# ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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A SYSTEM OF ELECTRIC SUBWAYS is at once to be built by the city of Baltimore, Md., in accordance with a city ordinance adopted by the council last June and approved by the Mayor on Sept. 4. The ordinance creates an Electrical Commission made up of the Mayor, the City Register and the President of the Board of Fire Commissioners who are to appoint a Chief Engineer, who shall be a civil engineer, and also an electrical expert, to prepare plans and specifications and superintend the construction of the work. His salary is to be not more than $4,000 per annum. The subways are to accommodate all the overhead wires in the city except the trolley wires; they are to be built by day labor or by contract, as the commission shall determine, and $1,000,000 is appropriated for their construction.

A 4-FT. SUBWAY UNDER THE MILWAUKEE RIVER has just been completed by the Milwaukee Electric Ry. & Light Co. The subway is 226 ft. long and is made up of lengths of cast-iron pipe 4 ft. in diameter, 12 ft. long and 1½ ins. thick. The subway extends between two manholes on either side of the river, each 8 ft. in diameter and about 30 ft. deep. In laying the pipe four lengths were joined together, making a section 48 ft. in length, and this was lowered from scows and the tapered end was guided by divers to enter the section already in place. The joint at the junction was then bolted up. The river at the crossing is 18 ft. deep, and a trench 12 ft. deep was dredged in the bottom in which the pipe was laid, and was afterward covered with lake sand. After the pipe line was completed and connected with the manholes, it was pumped out and all leaks were made tight. The entire subway was then filled with 3-in. ducts, of which there was room for 110. The manhole shafts were then lined with brick, and the ducts leading to the subway were put in place. The work was done under direction of Mr. Otto M. Rau, Chief Electrician of the company. Two more subways are to be built by the company at an early date.

A CHANGE FROM CABLE TO ELECTRIC TRACTION is to be made on the Broadway cable road in New York city, and work began on Sept 9. The present cable conduit will, of course, be used, and the principal work necessary is the placing in it of the insulated supports for the wires. The cable railway will, of course, continue in operation while the change is going on, and the work will therefore occupy a long time.

THE NEW EAST RIVER BRIDGE is progressing to the point of metal tower erection. Three of the four pier foundations are under way, and the two on the New York side are completed, with 23 ft. above high-water mark. On the Brooklyn side one foundation is within 14 ft. of the required height, or 23 ft. above tide, while the other caisson has not yet reached its final footing, 86 ft. below high-water mark; it is expected that this foundation will be finished in November. The contracts for the steel towers have not yet been let, owing to the financial condition of Greater New York. The $2,000,000 bonds lately authorized by Controller Coler will barely cover existing contracts.

THE QUEBEC BRIDGE CO., at its annual meeting, held in Quebec, has decided to at once call for tenders for a bridge to cost from $3,000,000 to $4,000,000. The capital subscribed amounts to $286,000, and the Dominion government has given assurance that a subsidy of 33⅓% on the cost of the structure would be voted at the next session of Parliament. The Province and the City of Quebec are both expected to grant subsidies. The site of the proposed bridge is opposite the Chaudiere, where the river is 2,595 ft. wide, at high water, and the water is 43 ft. deep. The length of bridge required is 3,100 ft., and the distance from the bed of the river to the lower chord will be 193 ft.

FIVE NEW PIERS ON THE NORTH RIVER, New York, are nearing completion, and are to be finished by the end of the year. These piers are intended for the use of the White Star, Cunard and the Wilson Steamship lines. The total cost to the city of these five piers is $6,000,000, and the shedding over them will cost about $1,250,000 more. The contract for erecting the sheds on all five piers has been awarded to R. P. & J. H. Staats. The two White Star piers are 760 ft. and 732 ft. long; the Wilson Line pier is 732 ft. long, and the two Cunard piers are 718 and 704 ft.; and each pier is 125 ft. wide, except the upper one of the Cunard piers, which is about half that width. The sheds will be one or two-story steel structures, with a continuous two-story bulkhead shed, 1,750 ft. long and 50 ft. wide, connecting all the piers. This bulkhead pier will contain the power, lighting and pumping plant. The annual rental basis for a term of ten years is as follows for the several lines: White Star, $168,750 per annum; Cunard Line, $117,088; Wilson Line, $84,375.

THE DECLINE OF NEW YORK'S FOREIGN TRADE is being investigated by a commission appointed by Gov. Black. The commission is made up of Hon. Chas. A. Schieren, Chairman; Alexander Smith, Secretary; Hon. Andrew H. Green, C. C. Shayne and Hugh Kelly. The subjects to be investigated by the commission are as follows: 1—Deepening of the channel. 2—Dock rentals. 3—Port charges. 4—Pilot fees. 5.—Matter of the availability for commerce of the water front above Hell Gate and beyond Fort Hamilton. 6—Warehouse facilities. 7—Grain elevator charges. 8—Differential railroad rates. 9—New York's lighterage system. 10—Bearing of the Erie Canal upon the commerce of New York. 11—Status of Canadian Canal competition upon New York's commerce. 12—Western demarkation line of territory contributory to New York. 13—Comparative charges at New York and other ports. 14—The establishment of a complete statistical department by the city of New York. The commission will hold its public sessions in the New York City Hall.

AMERICAN HARDWARE, says the "Hardware Record," of London, is rapidly entering the English market, and "American competition is going to be far more severe than it is at present." The export line includes bright drawn steel and all the cheaper grades of steel, brass rods, files, small malleable castings, automatic machinery for all purposes, rubber steam hose, etc. These goods, says the "Record," are now from 25% to 50% cheaper than the prices quoted on English goods in the same line. As to quality, the English workmen are said to prefer the American raw steel and brass, as being more uniform in quality and more easily worked into shapes.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Sept. 12 on the Texas & Pacific Ry., between Jefferson and Texarkana, Tex. At this point a bridge across a branch of the Sulphur River had been weakened by the high water following a cloudburst and an east bound four-car passenger train went through into the river, killing one passenger, mortally injuring a porter and seriously injuring five other persons.

A SERIOUS DISASTER to the German torpedo flotilla, which has been participating in the naval manoeuvers in the Baltic and North seas, is reported to have occurred on Sept. 10. It is stated that one torpedo boat was sunk, two 150-ton boats completely disabled, and 12 others seriously damaged. Seven lives were lost.

A BREAK IN A PUMPING ENGINE at the Grand Rapids, Mich., water-works on Sept. 1, put the city on a short supply for two days, and left a part of the hill section without any water. The pumps was on the Holly direct system, of 7,000,000 gallons capacity, and had been running without a stop for four months. The plunger rod of one of the plungers, which was 5 ins. in diameter, and turned down to 4¼ ins. at the screwed end, stripped its screw threads, drawing itself out of the nut, which was 4½ ins. thick. The engine then began to race, but it was stopped before any further damage was done. The calculated pressure exerted by the plunger, which is 25 ins. diameter, working against a pressure of 90 lbs. per sq. in., is 4,488 lbs. The metal to be sheared by stripping the threads could not have been much less than 50 sq. ins. even if the threads were of the weakest form, or square threads, giving a very large factor of safety against ordinary stresses. It is probable that the nut had worked loose, and that this occasioned a hammer blow upon the threads, which in time would cause them to break.

DRY-DOCK NO. 3, at the Brooklyn Navy Yard, shows no signs of weakness in use, and the slight seepage of fresh water at the southern end gives no concern. The battleship "Oregon" has just been taken out of this dock, and the battleship "Massachusetts" is the next vessel to be docked in it. This is the dock which gave so much trouble, and which has been repaired under the charge of Naval Constructor Bowles.

THE BATTLESHIP "OREGON" has had her four breech-loading 6-in. guns replaced by four 6-in. rapid-fire guns, and her smoke-pipes have been lengthened 10 ft., so as to secure better draft when the blowers are not running. The battleship "Massachusetts" is also having her old 6-in. guns replaced by 6-in. rapid-fire, and her smokestacks lengthened in a similar manner. Both the "Oregon" and the "Iowa" are ready for sea again. The cruiser "Atlanta" is having her engines changed from compound to triple-expansion. It is expected to gain three to four knots in speed by this change, with little, if any, more coal consumed.

SMOKELESS POWDER FOR THE U. S. NAVY, to the amount of 1,000,000 lbs., is to be provided by contracts now made with the California Powder Co. and the Dupont Powder Co.; each is to furnish half the above amount at 80 cts. per lb., the government furnishing the alcohol used in the production of the powder.

THE WEIGHT OF SHELL CHARGES used in the United States Naval service—that is, the weight of powder with which explosive shells are charged—are as follows, black gunpowder being used in all cases:

| | | | | | |
|---|---|---|---|---|---|
| 1 pounder, | 200 grains. | 6 in., | about | 4½ | lbs. |
| 3 " | 900 " | 8 " | " | 11 | " |
| 6 " | 1,400 " | 10 " | " | 20 | " |
| 4 in., about | 2 lbs. | 12 " | " | 40 | " |
| 5 " " | 3 " | 13 " | " | 50 | " |

THE THREE BATTLESHIPS, lately bid for, are to be built upon the plan submitted by the Cramps, according to the decision of the Navy Department. The Newport News Co., the Cramps and the Union Iron Works, all submitted plans for fast ships, but those submitted by the Cramps were found to be the only ones entirely satisfactory to the Department. The Board of Naval Bureau Chiefs has now invited the Newport News Co. and the Union Iron Works to amend their plans so as to make their ships identical with that proposed by the Cramps. Both companies have practically agreed to do this, and it is understood that each of the three companies will receive a contract for one ship.

THE PROPOSED OTTAWA AND GEORGIAN BAY ship canal is still attracting attention in Canada. McLeod Stewart, of Ottawa, has made the following proposition to the Canadian government on behalf of the Montreal, Ottawa & Georgian Bay Canal Co. The company will build a canal with locks of 14 ft. depth, so that steamers of that draft can pass from Montreal to the Great Lakes via the Ottawa River. It will employ only Canadian labor and Canadian sub-contractors, and will use plant and machinery made in Canada, so far as procurable. It will complete surveys within ten weeks from the time the concession is approved. The guarantee required of the government by the company is $340,000 a year for 20 years, or 2% on $17,000,000, which the company gives as a provisional estimated cost of the work. No part of the guarantee need be paid till one year or more after the entire completion of the canal. The annual payment shall be diminished by the amount of the net earnings of the company. Thus, if the company makes net earnings of $140,000 the first year, the government would only have to pay $200,000. Finally, the company will agree to repay any expenditures of the government on account of the guarantee fund from its future earnings, and the government will hold a first lien on all property and franchises belonging to the company. The offer has been approved, it is said, by the well-known contracting firm, E. Pearson & Son, of London, who are the financial backers of the enterprise.

THE LARGEST CARGO EVER CARRIED on the lakes was taken last week by the schooner "Roebling," of the new iron ore fleet, from the docks at Duluth. It consisted of 7,865 net tons of ore. The vessel was towed by the steamer "Stevenson," of the same fleet, which also towed the schooner "Nasmyth," the combined cargo of the three vessels being 19,761 net tons, the largest tonnage ever drawn by one engine on the lakes. By the plan of having one large steamer take in tow two large schooners, all laden with ore, the cost of transportation is greatly reduced, a matter of the utmost importance in the cheapening of the cost of iron and steel production.

## PORTABLE PLANT FOR MANUFACTURING ASPHALT PAVING.

The use of asphalt paving has in the past been practically limited to the larger towns and cities, owing to the fact that the asphalt has to be prepared in a special plant, the cost of establishing which precludes its introduction in places where only a limited amount of work can be expected. In order to overcome this difficulty there has been devised and patented a special portable plant, which is complete in itself and can be transported by rail from place to place on its own cars in regular freight trains. With such a plant, supplemented by a steam roller and the special street tools required, a contractor can undertake small pieces of work, as there is no expense for the erection of permanent plants, and when the working season is over the plant can be closed up and stored on a side track or in a shed.

The design of the Hetherington portable asphalt plant, which is described in the present article, was not an easy matter. It was necessary to combine a large number of bulky appliances and special machinery for a complete factory within small compass, upon cars suitable for transportation on railways. It was also necessary to provide a housing and working platforms, and to so arrange the plant that it could be operated conveniently and economically. Furthermore, it was necessary to provide such joints and sectional parts that the entire plant could be packed and enclosed within cars whose dimensions should not exceed the limitations of tunnels, bridges, etc., while at the same time all parts had to be made strong enough to stand the shocks and vibration due to railway service without requiring undue expense for repairs.

Fig. 1 shows in operation a large Hetherington plant recently built for the Assyrian Asphalt Co., of Chicago. Fig. 2 shows a similar plant closed and ready for transportation, but it must be noted that the front car in Fig. 1 is the rear car in Fig. 2.

The plant is all contained upon two cars. One of these, termed the drier car, is 42 ft. long; the other, or melter car, is 36 ft. long. Both are 9 ft. wide. Each car has an underframe of six steel longitudinal sills, composed of 12-in. I-beams and 12-in. channels, and stiffened by eight truss rods. Steel body bolsters are built into the framing, and the diamond trucks have also steel bolsters. All castings are of steel and the only wood used is for the deadwoods, which are of oak. The floor is of ¼-in. steel plates, riveted to the steel sills. The cars are fitted with automatic couplers and air brakes, and are built with due regard to the M. C. B. standards.

The equipment of the drier car includes a 50-HP. steam boiler of special design, a 35-HP. steam engine, a boiler feed pump, a sand elevator and conveyor of the link belt type, two drums for heating sand, an air compressor and a double rotary air exhauster to create the necessary artificial draft for the fires of the heating drums. The equipment of the melting car consists mainly of a steel cylinder or agitator, and three or four melting kettles or tanks, each having a capacity of about seven tons of asphalt. These kettles are enclosed in a housing of steel plates, and between them are partitions of hollow fireproof tiles of special design. Similar tiles are used to line the housing, an air space 1 in. wide being left between the tiles and the steel plates. These tiles form an effective insulator against loss of heat and are much lighter in weight than ordinary firebrick. All the tiling and furnace masonry is so built as to be proof against damage by the vibration and jarring of the cars when traveling. The furnaces are above the car floor, the grates being let into the floor, so that there is no projection below the framing.

The cars are run upon a side track at a convenient site for the work, and are placed about 7 ft. apart, the wheels being blocked, and the corners of the cars supported by screw jacks. The sides of the drier car (the leading car in Fig. 1 and the rear car in Fig. 2) are then opened, the lower part falling down to form a working platform, and the upper part forming a roof or shelter, all supported by tubular posts which form part of the equipment. On the melter car, the inclined roof, hinged at the eaves, is folded back and forms an upper working platform above the kettles, supported by inclined braces. A light steel framing supports an awning over this platform. Between the cars is built an elevated tower, spanning the space between their ends, and having its four columns supported on the corners of the cars. This tower is built of light tubing and steel beams. Upon it, about 9 ft. above the ground, is a platform carrying the mixer, in which are mixed the necessary proportions of asphalt, carbonate of lime and hot sand to form the paving material. Suspended just above this is the sand measuring box, which contains the amount of sand required for one charge of the mixer, and is supplied from the hot sand storage bin, at the top of the tower. The latter is a large rectangular steel bin, containing a revolving screen to take out the gravel and coarser particles from the sand. Underneath the tower, and between the cars, is a roadway for the asphalt wagons.

In operation, asphalt is placed in the melting kettles, and sand is shoveled into the buckets of the cold sand elevator, seen at the side of the front car in Fig. 1. This delivers the sand into the heating drums, from which it passes into the boot of the enclosed vertical hot sand elevator, by which it is carried up to the screen, and thence falls into the storage bin. It might seem to be a better arrangement, however, to screen the sand first and not waste fuel in heating gravel, etc., which is not needed, but we are informed that there is so very little gravel in the sand as to have practically no effect on the fuel consumption, and that by using the overhead screen the refuse can be carried away by a chute without having to be rehandled. While the sand is being heated the asphalt is being melted in the kettles and thoroughly stirred in the cylindrical agitator.

When the materials are ready, the operator on the melting car opens a valve in the spout of the agitator and allows a certain amount of asphalt to flow into a steel bucket, in which it is automatically weighed. As the operator at the mixer allows the hot sand and the carbonate of lime to fall into the mixer, the bucket of asphalt is run to the mixer on a short trolley track and poured into the box. The mass is mixed violently for a short time, and the operator then pulls a lever which opens a door at the bottom of the mixer, allowing the charge to fall into a wagon standing between the cars.

The capacity, as demonstrated by actual work this season, is said to be from 1,800 to 2,400 sq. yds. of paving per day. The plant was invented four years ago, but was not fully developed until last year. The latest and largest plant is one recently completed for the Western Paving & Supply Co., of Chicago. Several plants have been built and have been operated successfully at Oswego, N. Y.; Lima, O.; Toledo, O.; Houston, Tex.; Bluffton, Ind., and Grand Rapids, Mich., where a considerable amount of work has been done. The inventor is Mr. Frederick A. Hetherington, to whom we are indebted for photographs and information, and the plants are built by Hetherington & Berner, of Indianapolis, Ind. The same firm also builds stationary asphalt plants.

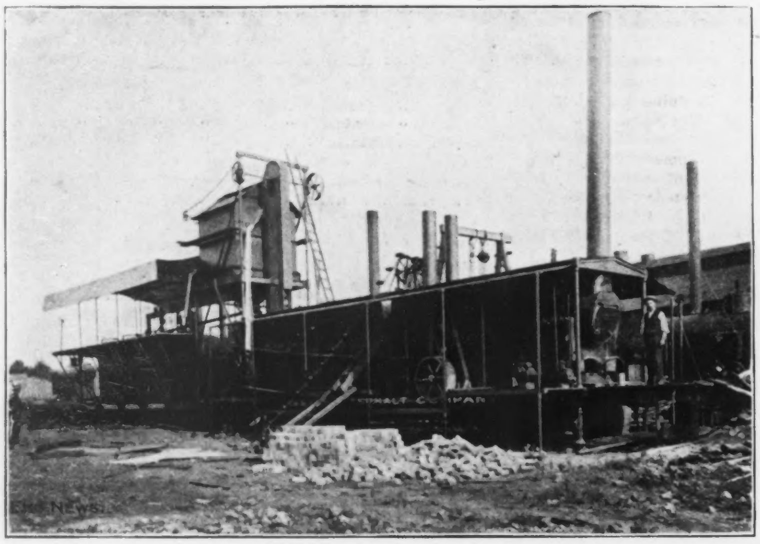

FIG. 1.—PORTABLE ASPHALT PLANT IN OPERATION.

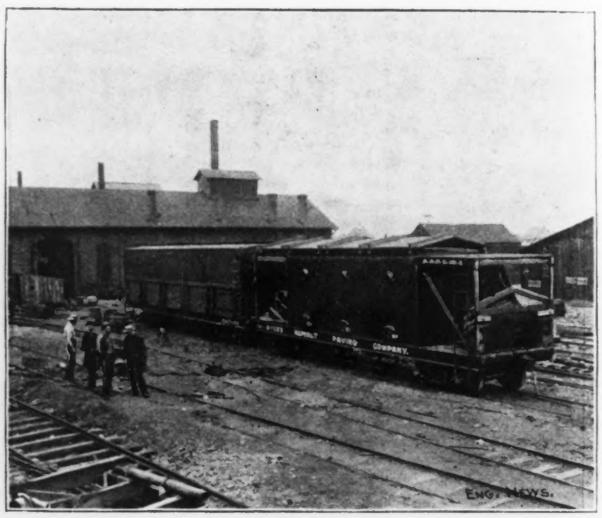

FIG. 2.—PORTABLE ASPHALT PLANT READY FOR TRANSPORTATION.

Frederick A. Hetherington, Inventor.

## EQUIPMENT AND MAINTENANCE OF ELECTRIC CARS.*

By M. S. Hopkins.

Car Bodies.—For years car builders have attempted to devise a car body which would be equally durable in both summer and winter, but judging from the character of equipment now in use on the majority of roads, such a car has not yet been produced. The combination car with movable parts is not satisfactory for winter use. It is troublesome, noisy and cold, and is lacking in many of the essential features of the open car for summer service. The open cross seat car of the barge type, with running boards on the side, seems by far the most desirable type of car for summer service, offering the largest seating capacity and the best facilities for receiving and discharging passengers, which is a great advantage in city service. Considering all features, the box car, with side seats, large windows, wide end doors to the side of a

*Condensed from a paper read at the annual meeting of the American Street Railway Association.

roomy platform and vestibules closed on one side, seems best adapted to the average conditions of winter service. While the vestibule type closed on one side is not so convenient for the handling of large crowds, yet the additional safety afforded on double track roads should receive full consideration, even at the expense of convenience. In localities where winters are accompanied with snow fall and freezing weather, the vestibule affords protection to passengers, and motormen, and conductors are able to render very much more efficient service.

The long car body seems to be growing in favor with the railway manager, due to the comparatively small increase in operating expense, in comparison to increased carrying capacity, and its allowing of the increase of headway or decrease in number of cars run, resulting in a large decrease in operating expense per passenger carried.

In the construction of box-car bodies, the trusses should be as deep as possible, and great care taken to secure a perfectly rigid fastening at end of sill, as the slightest deflection throws an undue strain on the joints and framing of car body. Where side sills are plated on the outside with steel plates, all season cracks should be thoroughly filled with a thick mixture of lead and oil, and the entire surface given a heavy coat of oil paint before the plate is put on. It is hardly necessary to say that sill joints should be well leaded and protected from moisture. A heavy steel roof rafter in one piece should be put in at every post, and a saving in maintenance will be made by having platform floors of oak or maple. The trolley stand should be mounted on a trussed support, which will distribute the strain to the ends of the car as much as possible.

Ash seems to be almost universally used in post and light framing of cars. This is probably due to the difficulty in securing the grade of oak necessary, the lighter weight of the ash and the greater ease with which it is worked. Yet, in spite of these difficulties, oak is far preferable, being stronger and more elastic, and a material that will give a far longer life.

Trucks.—Under the average conditions, a 22-ft. closed car or an 8 reversible seat open car body should be the limit for a single truck. Although there are single trucks which will carry a longer body fairly well, yet the increase in maintenance will in most cases warrant the use of double trucks. The local conditions should govern the type of double truck used, the bolster type in most cases being preferable for long cars on high speed, suburban service, while for city service, where heavy grades and quick starts demand maximum traction, and short curves make it necessary for the wheel to turn under sill, the bicycle or maximum traction type must necessarily be used. This type of truck is no longer an experiment, and while they possibly require more careful inspection and adjustment, very efficient service can be secured by their use.

Trucks should be made up of a small number of parts; cast and malleable pieces should be the lightest consistent with strength. Springs should be so arranged as to prevent oscillation, and give an easy riding car under all conditions from no load to full load, and when the truck is of such design as to prevent the use of an under truss, the spring base must be exceptionally long and end springs arranged to relieve strains on the car sills.

Electrical Equipment.—In the selection of electrical equipment the main point is to secure equipment of ample capacity and proper design for the service required. The bearings should be large and lubricated by oil from below and cup grease from above, and so designed that drip from bearings will fall outside of the frame. The armature should be so constructed as to permit the shaft being pushed out without disturbing the commutator and winding.

I am glad to note that the importance of light-weight and slow peripheral speed of armature has been recognized in recent designs of railway motors. The inertia or flywheel capacity of armature should be the smallest possible consistent with the work required. Engineers differ as to the best method of suspension. From a theoretical standpoint, the cradle or side-bar suspension has the lead. The dead weight is largely removed from axle, thereby eliminating to some extent the hammer blow on rail-joints, decreasing the wear on axle brasses and securing the better alinement of gears; yet, in practice, the nose suspension is still preferred by the writer, as the car starts more smoothly—the weight of the motor on the spring supports overcoming the jerk and quiver so common in other methods of support. The specifications for railway motors, as drawn up by leading manufacturers to-day, amount to practically nothing, and I would suggest that the purchaser of motors in his specifications clearly define the rating, heat limit and efficiency.

The series-parallel controller is in most respects a satisfactory device, the chief objection being the narrow range of speed on running notches. Specifications for resistance should provide that the last two points of resistance be of sufficient capacity to allow of their continued use as running notches, especially where cars are operated in city service.

There are several types of magazine fuse boxes or cutouts and single cutouts using a special fuse which possess a number of points of merit. Without going into detail, it is the opinion of the writer that, under average conditions, the standard magnetic blow-out fuse box, using a link fuse, is preferable.

Each car should be equipped with a thoroughly reliable lightning arrester. Points to be noted in selecting this device are as follows: The kicking coil, which should always be installed; the air gap, as small as possible; a positive and quick device for interrupting the current after discharge, and one which will not be injured by the discharge; a non-inductive resistance in the circuit which will limit the flow of current and thereby prevent the opening of the circuit breaker at station when several arresters operate at the same time.

Care of Equipment in Car Houses.—Generally one of the following three methods is used for daily inspection of equipment: Inspection of cars each trip; inspection of equipment at night by motor inspectors; and inspection of equipment during the day by motor inspectors and repair men.

In regard to trip inspection, I would say that in the present degree of perfection attained by manufacturers of railway equipment, trip inspection should not be necessary, except on interurban lines operating at high speed over long runs, and is of doubtful value, besides it is expensive. The period of time for making this inspection is necessarily very short, and the entire time is taken up in mere inspection—little or no opportunity being afforded in which to make repairs.

In regard to night inspection, the experience of the writer has been such as to absolutely condemn the method as expensive, slovenly and unsatisfactory. It is impossible to make a thorough inspection of cars at night, no matter how well lighted the car house may be, and the efficiency of the work done by the men is very far below that of the work during the day. Therefore, when local conditions will admit, inspection of cars during the day seems by far the most advantageous.

We will assume a car house station from which 25 cars or more are operated. There is usually one general foreman in charge of this station. His duties are chiefly those of the transportation department, but he should be a man thoroughly conversant with the usual troubles which may occur in the operation of the equipment, and know how to direct minor repairs. It would, of course, be better if he were able to personally superintend the actual work of repairs, but it is usually very difficult to find men who are good mechanics and likewise efficient in the transportation department.

For making inspection and running repairs such as should be made in car houses, it is a safe rule to have one man to seven cars. It is, however, important to have a man in all car stations, known as chief inspector of that division, who is thoroughly conversant with practical electrical and mechanical matters. This chief inspector should have under his care for inspection and repairs seven cars, and also have direction and supervision of the other two repair men who care for the remaining 18 cars.

The duties of these men should be to make a daily inspection of every car assigned to them, starting first with their motors, examining the grease in the cups, the brushes, cleaning the motors, examining connections, etc. They should remove the covers from their controllers about once in three days, and oil the same very lightly with vaseline or grease, remove any blisters which may have appeared on the contact points, and carefully examine the adjustment of contact fingers. Too much emphasis cannot be given to the inspection of all brake rigging, and very thorough inspection should be made daily from the brake-handle to the brake-shoe, and the brakes tried by inspectors before car is placed in service. A broken brake-chain or worn out shoe, a broken brake-clutch or a broken brake-pin are things that should never occur through neglect, and if an accident of this kind does occur, the cause should be immediately traced and the responsibility located. Economy in maintenance should never be exercised at the expense of absolute safety, and brake-chains, pins and shoes should be discarded long before the danger point is reached.

The actual repair work done by these inspectors should be all work possible to be done without the use of machine tools, or which, if done by them, will not require the loss of car from service for a period of more than two hours.

The question as to how often car equipment should be taken to the shops for a general inspection and overhauling, and to what tests the electric equipment should be subjected at the time of inspection, are subjects on which electrical engineers widely differ. Considering the average conditions, and assuming that equipment is in good condition, it is the opinion of the writer that the taking of cars to shops every six months should maintain the equipment in good condition and assure its efficient operation.

Motor Bearings.—Bearings should be run "close" at all times; the time of their renewal being determined by the effect of the wear on the gear and pinion, as the wear on these parts is largely affected by the wear of the bearings.

After a series of tests, covering quite a period of time, as to the wear of various materials used in motor bearings, the writer feels warranted in making the statement that either the best grade of Babbitt or brass bearings should, under the ordinary conditions, give a longer life than six months, and when a bronze bearing of the proper mixture is used and properly lubricated, a life of twelve months can safely be expected. The method of lubrication largely influences the life of brasses. The writer has, after long tests with various lubricants, discontinued the use of grease entirely on armature brasses, and in most cases on axle brasses, a good grade of engine oil, supplied through wicks, being more satisfactory and economical. In order to reduce the maintenance of brasses to a minimum, the use of phosphor bronze is strongly recommended. Street railways operating 25 or more cars will find it economical to cast and machine their own brasses.

Rough and burnt commutators are too frequently the cause of expensive motor repairs, and usually indicate imperfect motor design or inexcusable neglect. Well designed motors in good condition, even under the hardest service, provided, of course, the average work is within the rated capacity of the motor, should not require turning oftener than once in eight months. There is nothing that so well indicates to the practical man the conditions of the motor as the condition of the commutator. Whenever the commutator shows signs of burning or blackening, steps should be at once taken to prevent it. It is not advisable to try to prevent this by the continual sanding of the commutator by motor inspectors, though the occasional cleaning up of the commutator with sandpaper is necessary with all motors. The causes of trouble of this character are so numerous that mention is made of only a few of the more important.

Brushes should be soft, close-grained carbon, treated with a good lubricating compound—one which does not flow too freely from the heat from the motor, and which will not burn and carbonize on the commutator. The tension on the brushes is, as a rule, too light on railway motors. It is a common belief that heavy tension causes wear of commutator, but experience has shown that the actual wear of commutator due to friction of the brush is very small, and that increased tension will, in some cases, materially decrease the sparking, which causes the greatest wear. Improper alinement of brush-holders frequently causes sparking. In recent practice the use of side contact springs on brushes has been generally abandoned. On motors carrying heavy currents this spring is quite essential, as excessive heating of brush is caused by limited contact in the holder.

Commutator insulation should be made of what is known as the built-up mica, segments of the very softest grade of amber mica. A hard, clear mica should never be used in commutator, as this mica will not wear away as fast as the copper, and there is nothing so disastrous to the life of the commutator as high mica insulation.

The Electrical Testing of Railway Equipment.—Elaborate systems for the periodical testing of insulation on railway equipment seems to be growing in favor with some electrical engineers, but the practical value of these elaborate tests is not fully demonstrated. Experience has shown that tests of this kind are very misleading, and frequently cause the dismantling of equipment which, under ordinary conditions, had no tests been made, would have continued in service for a long time.

Judging from my own experience, it is neither necessary nor advisable to periodically test the insulation on the equipment, but to make such tests only in cases where motors are not working properly. The proper training of motor inspectors as to the little points about railway equipment which clearly indicate trouble with motor will in nearly all cases locate trouble due to weak insulation so that it can be remedied before any serious damage has resulted to any other part of the equipment.

All armature and field coils repaired should be carefully tested as to resistance and insulation to ground, and on all armatures having coils repaired, new commutator put on or commutator turned, resistance between commutator bars should be very carefully measured; using, preferably, a portable Wheatstone bridge testing-set, capable of showing clearly a variation in resistance of 1-1,000-ohm. This is one of the most important tests to be made in the care of railway equipment, as more burn-outs of armatures are caused by the slight short circuiting coils, due to solder, acids or copper turnings bridging over insulation between bars under leads than from any other cause, which can only be located by a test of this kind. Any mistake in connecting up the leads or a bad joint will at once be detected before any damage has been done.

Car Wheels.—Much has been written of late on the subject of car wheels, their wear and alinement, and still street railway managers are careless about their wheels. Too much care cannot be given to the sizing and alinement of wheels, and the pressure with which they are forced in the axle. At least 50% of the wheels removed from the cars throughout the country are caused by broken or sharp flanges or a broken wheel. The use of sand largely influences the life of wheels; but the conditions vary so widely I would not be justified in saying that a sandbox should in no instance be placed upon a car. Where it is possible to successfully operate without them, however, sand boxes should be discarded and other means used for sanding the track. It is in most cases far more economical to fit up a special car, capable of carrying a large amount of sand, and sand the track for say 100 ft. before each point where a stop is likely to be made, and on grades and in places where the track is exceptionally slippery than to sand the rail for its entire length.

Repainting of Cars.—The experience of the writer has clearly demonstrated that it is satisfactory to repaint cars without removing all of the old paint. Patent varnish removers, scalers, etc., are a snare and a delusion. The writer has found the following system of repainting cars to be quite satisfactory: First, remove all old paint by softening it with a blow-pot just enough to allow it to be scraped off with a broad putty knife, not allowing flame from the blow-torch to at any time strike the bare wood. Sand surface off well with block and sand paper. Where any new work has been put in, it should be first primed with a coat of boiled oil and a little lead and allow it to stand for not less than four days. Dashes and all iron work should be thoroughly cleaned with a strong alkali and primed with a coat of linseed oil put on boiling hot and allowed to thoroughly harden; giving one coat of oil and lead before color. If surface is rough, plaster with lead on this coat. Allow it to thoroughly harden, and sand with block; then lay on two coats of flat lead, two coats of color, varnish, stripe and ornament, finish with one coat of rubbing varnish and one coat of finishing varnish. The main object in the painting of cars should be to secure a hard, smooth surface which will hold out the varnish with the very smallest amount of material; the thinner this surface is the better. Care should always be taken where plaster is used to make it as thin as possible, and lead coats, color and varnish should all be carefully tempered, so as to set alike, as most cases of cracking of paint are due to the want of proper tempering and of lead and color coats.

A car painted in this manner should not require repainting for from 6 to 7 years, if properly cleaned and varnished. Cars should come into the paint shop, even where the best grades of varnish are used, once every eight or ten months, and be thoroughly washed down with pumice and strong soap and given a coat of finishing varnish.

After a number of trials of various floor paints and paints mixed especially for the purpose, the conclusion has been reached that there is nothing equal to pure white lead and linseed oil and suitable color for the floors of all cars. The majority of car floors are stripped, and it has been found impossible to find any material hard enough to stand on the top of the strips of a car floor, while almost any material will stand the wear, but not the moisture, between the slats. It is therefore very evident that the best paint for this purpose would be one which would best preserve the wood in the floor of the car from the constant moisture to which it is subjected.

As to the car roofs, the main object is to put as little material as possible on the canvas of car roofs, and that material should be elastic and yet withstand the action of the weather. No paint is too good for the car roof—the best white lead and oil giving the best results.

## METAL TRUCKS FOR FREIGHT CARS.

(With two-page plate.)

The great success which has attended the use of metal trucks for freight cars, and the extent to which such trucks are now being introduced, has led a number of designers and manufacturers to enter this field of competition, which is already sufficient to support a practically new industry. Some railway companies also have their own special designs of metal trucks. In an article on our editorial page, we have discussed the general questions incident to the use of metal trucks, and in the present article we describe a number of examples of different types of these trucks. These examples do not include all the metal trucks on the market, but they are sufficiently numerous to illustrate all the different types.

In this article we have divided the trucks into two classes: First, trucks having springs over the axle boxes, in which the whole weight of the car (except that of the wheels, axles and boxes) is carried upon the springs; second, trucks having springs under the ends of the bolsters, in which the weight of the body and the bolsters rests on the springs, leaving the weight of the truck frame to be carried rigidly upon the axle boxes.

In the Fox truck, which was about the first steel truck to come into general use, the springs were placed directly over the boxes, instead of under the ends of the bolsters, as was the usual plan, and this practically new arrangement was widely denounced as being objectionable, particularly on the ground that the short stiff springs would make the trucks ride very hard. From the fact that this truck has steadily grown in favor since its introduction, in 1891, it would seem that this is not of such great importance, or that it has been avoided, and it is particularly to be noted that many of the later forms of metal trucks have the springs arranged in the same way. Where the springs are over the boxes, there are usually two concentric springs to each box, placed in openings in the side frames, the center of the springs being coincident with the center line of the frames. In the Cloud truck, however, a nest of four springs is used, two on each side of the frame, resting on brackets in the boxes and bearing against top seats from the frames, the webs of the frames passing between the springs. In some of the Fox trucks, built for foreign railways, plate springs are used, placed outside the frames and over the boxes, and a somewhat similar plan has been devised for the Cloud truck, but in the latter case two sets of elliptic springs are used over each box, one set on each side of the frames.

### Metal Trucks with Springs Over the Axle Boxes.

The Ajax Truck.—This is a cast steel truck, composed of but three members (two side frames and one transom), each of which is a single casting of open hearth steel. The springs are over the boxes, and trucks of this type have no bolster. The construction is shown in Fig. 1. The side frames have the top horizontal from end to end, and are of I-beam section at the middle, made deeper and wider at the ends to form the pedestals, the flanges extending the full depth of the pedestals. Over the axle boxes the frame is enlarged and has the web made circular, to form a seat for the coiled springs. In some of the trucks the frames are lightened by apertures in the deeper parts of the webs. The transom is of rectangular section, with the top and bottom webs partly cut away between the center plate and side bearings to ensure lightness. The ends of the transom have flanges which fit between vertical ribs on the side frames, the transoms thus fitting snugly against the webs of the frames, to which they are secured by bolts. This arrangement prevents shearing strains upon the bolts. The truck weighs about 1,700 lbs., exclusive of wheels, axles, boxes and springs. It was designed by the Shickle, Harrison & Howard Iron Co., of St. Louis, Mo., and is manufactured by that company.

The Black Diamond Truck.—The side frames of this truck are built-up trusses, each formed of two 5-in. T bars. These are horizontal and 12 ins. apart for 15⅜ ins. at the middle, where they are riveted to the transoms. They then incline together and are riveted to cast steel fillers. Beyond these, the ends of the lower bar are curved down to fit against the inner side of the pedestals, while the ends of the upper bars are curved up to fit the top of the pedestals and then turned down vertically to form the outer legs. A double coiled spring is placed over each box. The transoms are 12-in. I-beams or channels, extending through the side frames and riveted to top and bottom gusset plates. Horizontal I-beam spacing pieces are riveted between the webs of the 12-in. I-beams. The truck weighs 1,200 lbs., exclusive of wheels, axles, boxes and springs. The manufacture has only recently been commenced, but some experimental sets are in use, and the specifications for 100 steel frame gondola cars of 70,000 lbs. capacity, for a foreign railway, contain the following clause:

> The diamond type of truck will not be permitted, and preference will be given to the "Black Diamond" or equivalent design, which insures strength, easy repairs, and arrangements to keep the truck square to its work.

One of these trucks was tested by Mr. Robert McKenna, Master Car Builder of the Delaware, Lackawanna & Western R. R., who loaded the truck with 60,000 lbs. of pig iron. This load caused a deflection of ¼-in., but there was no permanent set. The Black Diamond truck was designed by Mr. R. W. Oswald, and is manufactured by the Jackson & Woodin Mfg. Co., of Berwick, Pa.

The Cloud Truck.—This is built up of pressed steel members, and is shown in Fig. 2. It has flanged steel side frames, flanged inward on top and bottom and forming both legs of the pedestals. These frames are horizontal on top and bottom, but are made deeper at the pedestals than in the middle, while the flanges are wider at the middle and serve as gusset plates for the transom connections. The transoms are flanged steel channels, placed back to back. The center bearing is riveted to the transoms, and the side bearings are riveted to the top gussets of the side frames. The ends of the transoms are riveted to the side frames, and also to the top and bottom gussets of these frames. One of the special features of this truck is the arrangement of the springs, which, though placed over the boxes, are clear of the side frames. The webs of the frames come closer down to the boxes than in the Fox, Schoen and other trucks, where the springs occupy the openings in the webs of the frames directly over the boxes. To effect this, heavy malleable iron pedestals are used, with legs of T section, forming wearing surfaces 6 ins. wide for the boxes. These pedestals are riveted to the outside of the frame plate, and their width is sufficient to form a top seat for a nest of four coil springs, 4 ins. diameter, two on each side of the frame plate, with the web of the plate between them. This allows for the use of springs less rigid than where only two concentric springs are used, thus making an easy riding truck. A horizontal bolt, with spacing sleeve, is passed through the bottom of each pedestal. For tenders and cattle cars, two pairs of elliptic springs are placed over each axle box, instead of four coil springs; the pedestals being of special type to receive the elliptic springs. This arrangement is also shown in Fig. 2. There is no difference in the cost of the truck frames, whether coil or elliptic springs are used. The truck frame for a 60,000-lb. car weighs 1,350 lbs., and that for a 100,000-lb. car weighs 2,100 lbs., both exclusive of wheels, axles, boxes and springs. There are now about 2,600 of these trucks in service, including those under 30 steel cars of 100,000 lbs. capacity on the Pittsburg, Bessemer & Lake Erie R. R. The truck is the invention of Mr. John W. Cloud, and is owned by the Cloud Steel Truck Co., Old Colony Building, Chicago, of which Mr. Willard A. Smith is President.

The Fox Truck.—This was the pioneer of steel truck frames, and of pressed steel frames in particular, and was first manufactured in England, at the works of the Leeds Foundry. Each side frame is one plate of pressed steel, flanged inward at the top and ends, and slotted for the axle boxes, the pedestal legs being reinforced by pressed steel pieces of horseshoe shape, riveted to the frame, and a bolt with spacing sleeve holding the lower ends of the legs together. The frames are higher at the ends, over the axle boxes; and at the middle the top flanges are widened out to form gusset plates for the attachment of the transoms, which are pressed steel channels set back to back. The placing of the springs above the axle boxes was a decided innovation at the time when the truck was introduced (about 1891), and this feature was for a time the cause of much opposition. In spite of this, however, the truck has steadily grown in favor and is now in very extensive use, there being a very large number of freight cars in this country equipped with Fox trucks, while the arrangement of the springs has been copied in several other forms of steel trucks. In special cases semi-elliptic plate springs are used, placed outside of the frame plates. The weight of one truck, as used on the New York Central R. R., is 1,382 lbs. The trucks are manufactured by the Fox Pressed Steel Equipment Co., of Pittsburg, Pa.

The Hewitt Truck.—In this truck the side frames are formed of a special rolled steel shape, the section of which resembles an I-beam with the web extended through the flanges, forming a top and bottom T section, as shown in Fig. 3. The frame is 17 ins. deep over all and 12 ins. deep over the flanges. At the ends, the web is cut away and the T-shaped flanges thus left are spread apart vertically, forming top and bottom jaws to receive malleable iron pedestals. Each pedestal has its inner face slotted to receive the edge of the web of the frame, and is secured by one pedestal bolt on the outside, the bolt passing through the pedestal and the ends of the frame flanges. By removing these bolts, and thus releasing the pedestals, the wheels and axles can be removed without taking the truck from under the car. The transoms are 12-in. channels (though Z-bars are shown in the drawing). The channels are set with their flanges outward and are attached to the side frames by vertical angle iron connections and horizontal gusset plates on top and bottom. A double coiled spring is placed over each axle box, the top of the spring being covered by a hood or cap forming part of the pedestal. The truck is designed to have inside hung brakes. Rolled steel is used for all the parts except the center plate, saddle and pedestals, which are of malleable iron. The truck weighs (without axles, wheels, boxes or springs) about 1,400 lbs. It was designed by Mr. H. H. Hewitt, (General Manager of the Union Car Co.), who is President of the Hewitt Steel Truck Co., of Buffalo, N. Y. Its manufacture has not yet been commenced commercially, owing to delays in getting the special section rolled and in procuring the heavier forging machinery which experience has shown to be necessary, but the company already has orders for over 500 pairs of these trucks.

The Joughins Truck.—This was one of the first freight car trucks made up from structural shapes, and was designed with the idea of abandoning the use of the more expensive pressed steel shapes on that style of truck which has the springs placed on top of the journal boxes. Each side frame is made up of an I-beam, and the transom is formed by two I-beams, which are connected to the side frames by vertical angle irons and horizontal gusset plates. A special feature of the truck is the open-ended pedestal, which allows the wheels and axles to be removed after jacking up the car only just enough to ease the spring, instead of having to jack it up the entire height of the pedestal legs.

This pedestal has its outer leg formed by a hinged or removable piece. In one form of truck the ends of the side-frame I-beams are split horizontally and opened out, the superfluous metal in the web being cut away, leaving the top and bottom flanges. A bent steel T-bar riveted to the web forms the top and inner leg of the pedestal, the outer leg being an L-shaped piece of east steel hinged to the outer end of the top of the pedestal and bolted to the bottom of the inner leg. In another form of the truck the fixed part of the pedestal is a cast steel piece in the form of an inverted L, riveted to the end of the side frame, while another L-shaped piece, secured by a bolt at each end, completes the pedestal. By removing the bottom bolt in either form of truck the loose outer piece of the pedestal can be swung up, clear of the axle box, and the wheels can then be run out.

The weight of the truck is about 1,200 lbs. (exclusive of wheels, axles, boxes and springs). Some of the trucks are now in experimental use under tenders on the Norfolk & Southern R. R., and have been in service for more than two years. They were designed by Mr. G. R. Joughins, who was until recently Superintendent of Motive Power of that road, and were built to his order by the Baldwin Locomotive Works.

The Kindl Truck.—This is another truck built of standard rolled shapes riveted together, but each side frame is a truss (as in the Black-Diamond truck), instead of being formed in one piece. Each frame has one tension member, one compression member and a single tie member, the arrangement resembling somewhat that of a diamond frame. The construction is clearly shown in Fig. 4, which represents a truck for 60,000-lb. cars. Two steel angles, placed back to back and riveted together, form the outer legs and tops of the pedestals. They diverge vertically between the pedestals, the top or compression member curving down 4½ ins. to meet the top of the transom, while the tension member is dropped to meet the bottom of the transom and horizontal tie angle. The inner legs of the pedestals are formed by angle irons (which serve as the guides to the axle boxes) and web plates. Over each axle box is a double coiled spring. The transom is built of two 15-in. channels, 2 ins. apart and toed out. Between them, at each end, is placed a channel end-cover with its flanges vertical and its back outward. To these end pieces the side frames are secured at top and bottom. A ¼-in. horizontal gusset plate extending between the center lines of the axles is riveted to the top angle of each side frame and to the top of the transom. This plate is 7 ins. wide at the ends, and 12 ins. at the middle, and is bent to conform to the curve of the top member of the side frame.

The truck frame for cars of 60,000 lbs. capacity weighs about 1,390 lbs.; that for 80,000-lb. cars, 1,510 lbs., and that for 100,000-lb. cars, 1,900 lbs. These trucks are now in use on 50 new steel hopper cars of 100,000 lbs. capacity on the Pittsburg, Bessemer & Lake Erie R. R., and six coal cars of 60,000 lbs. capacity on the Illinois Central R. R., while orders are being filled for 200 additional cars for the latter road. The truck frame was designed by F. H. Kindl, Chief Engineer of the Carnegie Steel Co., and is manufactured for the Kindl Car Truck Co., Old Colony Bldg., Chicago, by Wm. B. Scaife & Sons, of Pittsburg, Pa.

The Schoen Truck.—While this truck is built up of pressed steel shapes, and appears at first sight to be similar to the Cloud and Fox trucks, it is composed of a greater number of parts than most trucks of this material, the claim being made that in case of accident the truck can be repaired at the railway shops, instead of having to be sent to the maker for new frames or parts. In most metal trucks, however, one of the principal objects of the design is to keep the number of parts as small as possible, and this reduction in parts is very generally held by railway men to be a specially important feature of such trucks.

In the Schoen truck, shown in Fig. 5, each side frame consists of three main parts: (1) A horizontal top member of channel section, with the flanges upward, the ends of this member being turned down vertically to form the outer leg of the pedestals. (2) A horizontal flat bar for the bottom member, the ends being turned up to form the inner legs of the pedestals. (3) A web plate flanged inward on top, bottom and both ends, the flanges being riveted to the top and bottom members and inner pedestal legs. The legs of each pedestal are connected by a horizontal bolt at the bottom, with a spacing sleeve between the legs, and the inner legs are further strengthened by gussets or knee brackets riveted to the legs and the bottom members of the side frames. Wearing plates, which are adjustable, are interposed between the boxes and pedestal legs, and double coiled springs are placed above the boxes. The transoms are pressed steel channels, set face to face, connected by the pressed steel center-plate and side-bearings, which are riveted to them, and having steel distance pieces on the inside. The webs of the channels are bent outwards at right angles at the ends and riveted to the webs of the side frames, while the top member of each side frame is made wide, flat and dished at the middle to form a gusset plate connecting the transom with the frame.

These trucks are manufactured by the Schoen Pressed Steel Co., of Pitsburg, Pa., and are in use on a number of railways. They have been applied to many of the all-steel, hopper-bottom cars of 100,000 lbs. capacity, built by this company for the Pittsburg, Bessemer & Lake Erie R. R. It is one of these latter trucks which is shown in Fig. 5, its weight being about 1,785 lbs., exclusive of wheels, axles, journal boxes and springs. The number of parts is as follows:

| | Thick. | | Thick. |
|---|---|---|---|
| 2 top members ...... | ½-in. | 1 center plate ....... | ½-in. |
| 2 bottom members.... | ½-in. | 2 side bearings...... | ⅜-in. |
| 2 side frame webs.... | 5/16-in. | 4 spring caps....... | ⅜-in. |
| 4 pedestal brackets.... | ⅜-in. | 8 wearing shoes...... | ¼-in. |
| 2 transom channels .. | 7/16-in. | 4 pedestal ties....... | .. |
| 2 tr'ns'm center braces | ⅜-in. | 4 pedestal bolts with nuts, washers & keys | |
| 1 distance plate....... | ⅜-in. | | |

Another form of truck is manufactured by this company, having side frames of the diamond type, but built up of pressed steel shapes. This is described later on. The builders state that their truck frames are in use under 5,000 cars. This is exclusive of metal trucks equipped with the Schoen bolster and small pressed steel parts, more than 100,000 cars being equipped with these.

### Trucks with Springs Under the Bolsters.

The American Truck.—This is an adaptation of a cast steel bolster to side frames of the diamond pattern. The bolster is a single casting of soft open hearth basic steel, in shape like an inverted trough, with vertical sides, deeper at the middle than at the ends. The center bearing, side bearings, column guides and top seats for the coiled springs are all formed in this casting. The ends of the bolster project through the side frames, under the top arch bars, and rest upon coiled springs. At the middle of each side frame is a steel casting which forms the bolster columns and lower spring seat. The side frames are connected to each other at the bottom by two flat wrought-iron braces, extending diagonally across between the columns. The ends of these diagonal bars lie between the lower arch bars and the tie bars, and are secured by the column bolts passing through them, while at their intersection they are riveted together.

The bolsters for cars of 60,000 lbs. and 80,000 lbs. capacity, and for tenders, are 13 ins. wide, 4 ins. deep at the ends, and 9 ins. deep at the middle. For 100,000-lb. cars they are 11 ins. deep at the middle. They are also made in smaller sizes for swing motion trucks and for narrow-gage trucks. Each bolster is tested by hydraulic pressure to several times the load it is to carry, and the date of the test is stamped upon it.

The trucks are adapted for either inside or outside hung brakes and the spring seats on the bolsters and column castings are made to receive any size or shape of helical or elliptic springs. The principal advantages claimed for these trucks are simplicity of construction, small number of parts, flexibility and lightness combined with strength to resist shocks and twisting strains. The trucks for 60,000-lb. cars weigh 1,574 lbs., exclusive of wheels, axles, boxes and springs. There are over 35,000 now in use on 130 different railways in this and other countries. They are manufactured by the American Steel Foundry Co., of St. Louis, Mo., whose works have a capacity of 200 trucks per day.

The Haskell & Barker Truck.—This is another application of a metal bolster to side frames of the ordinary diamond pattern. The bolster, however, is not in one piece, but is built up of top and bottom plates riveted to a cast-steel center piece or filler which is not solid, but is made in truss form. This truck is used on the 80,000-lb. coal cars of the Illinois Central R. R. (Eng. News, June 16, 1898). On these cars the bolster is 12 11-16 ins. deep at the middle and 7⅜ ins. deep at the ends, having a top plate ⅞ × 11 ins., and a bottom plate ⅝ × 11 ins. The ends of the bolster pass through the frames and have cast upon them the column guides for the malleable iron columns. Each end of the bolster is supported by a nest of coiled springs seated upon the spring plank, which is a 13-in. steel channel resting upon the lower arch bars of the side frames. The Illinois Central R. R. has 500 coal cars equipped with these trucks, which are manufactured by the Haskell & Barker Car Co., of Michigan City, Ind.

Northern Pacific Ry. Truck.—This railway is using an all-metal truck which was designed by Mr. E. B. Thompson, Mechanical Engineer of the road, and is manufactured at the company's shops. As shown in Fig. 6, it has side frames of the diamond pattern, with the American cast-steel bolster, described further on, the bolster extending through the side frames. A special feature of this truck is the use of the Barber roller, bearing under each end of the bolster. A broad saddle resting on the lower arch bar supports the end of the two angle irons ½ × 4 × 6 ins., 7 ft. 2 ins. long, which form the transoms, and on this are seated four coiled springs carrying a cap with two concave recesses on top to receive the two 2-in. rollers, which lie parallel with the track. On the rollers rests a similar cap attached to a wooden block or filler which is inserted into the end of the bolster. Mr. E. M. Herr, Superintendent of Motive Power, informs us that this truck operates very successfully and that it takes the curves more easily than the ordinary diamond truck without the roller-bearings. The top arch bar is only cambered 1 in. The bolster is of inverted trough section, with vertical fish-bellied sides, having heavy ribs on the inside of the lower edges. The center plate and side bearings are formed on the casting. Inside hung brakes are used on this truck.

The Player Truck.—This is still a third combination of side frames of the ordinary diamond pattern, with a cast-steel transom and bolster, but differs in many important respects from the other trucks described. The transom is a single trough-shaped casting, in which fits a cast-steel bolster of rectangular section. As shown in Fig. 7, the ends of the transom embrace the top and bottom arch bars of the side frames and are further secured by two column bolts at each end. The strain of the load is divided between the transom and the bolster. That upon the former is light on account of the points of support being immediately adjacent to the bearing points, while that upon the bolster is light on account of the use of a short bolster. The transom holds the truck in alinement, leaving the bolster merely the duty of easing the load upon the springs, which insures at all times the full benefit of the springs. In the ordinary diamond frame truck the bolster has this double service to perform, which results in producing a binding at the columns, causing great strain and wear with consequent shaking and loosening of the frame. The truck is adapted to the use of either coil or elliptic springs under the bolster, the latter being especially suitable for tenders. As the bolster does not extend into the side frames, the springs are consequently inside the frames, instead of being between the upper and lower arch bars as in ordinary practice. The transom is open at the ends, and the springs can be replaced through these openings after jacking up the bolster just enough to relieve the load.

The truck frame weighs complete about 1,500 lbs., the bolster weighing approximately 400 lbs. and the transom 650 lbs. It was designed by Mr. John Player, Superintendent of Machinery of the Atchison, Topeka & Santa Fe Ry., and is manufactured by the Shickle, Harrison & Howard Iron Co., of St. Louis, Mo., who are also the makers ot the Ajax truck, already described. There are a number of these trucks in service on the Atchison, Topeka & Santa Fe Ry., the Kansas City, Pittsburg & Gulf Ry., and other railways.

The Schoen Truck.—The Schoen web-frame truck, with springs over the axle boxes, has already been described, but the same company also makes a truck with diamond frames built up of pressed steel shapes. In this form of truck, shown in Fig. 8, each arch bar is of channel section, inverted, and is flared out at the middle to form a gusset plate for the transom connections. Over the axle boxes the lower bar fits inside the upper arch bar, and the two are riveted together. The upper bar is 7-16 × 6⅞ × 2 7-16 ins., and the lower arch bar is ½ × 5⅞ × 2 ins. A flat bar, ⅝ × 5½ ins., with its ends turned up, forms the tie bar, but this is 4 ins. below the lower arch bar, to which it is connected by a double channel piece at the middle. The transoms are pressed steel channels, set with the flanges outward, the channels being 15 11-16 ins. apart, back to back. While the springs are placed in the transverse center line of the truck, as in ordinary diamond trucks, they are not in the longitudinal center lines of the frames, but are set well inside the frames, the center lines of the springs and frames being 11¼ ins. apart. The springs are supported in a rather novel manner. A stirrup or U-shaped piece is attached near each end between the transoms, its sides being clear of the transom channels, while its top horizontal flanges rest upon and are riveted to the top flanges of these channels. The loop of each stirrup supports a saddle or seat for the coiled springs upon which rests the end of the bolster.

The bolster is built up of pressed steel parts riveted together, and is fish-bellied in shape, 12 ins. deep at the middle and 7¼ ins. at the ends. It is formed of two channels, with the flanges set inward, connected by the center plate, end plates and distance pieces. It is only 5 ft. 6 ins. long, being entirely clear of the side frames. The transoms have a great part of the vertical web removed from that part which lies between the spring hangers. The part that remains is sufficient for strength, but the makers state that by the removal of the web the torsional resistance of the transoms is so much reduced that the truck frame has great flexibility in a horizontal plane. This flexibility, they claim, enables the truck to readily adapt itself to inequalities of as much as 3 ins. in the track, without straining the riveted structure. The wheels, axles and boxes can be removed as readily as in the ordinary diamond truck. The truck frame is made accurately square in construction, as the bolt holes for the journal boxes are all drilled at once, after the truck frame has been completed in all other respects. The following is a list of the parts used to make up this truck:

| Frames. | Thickness. | | Thickness. |
|---|---|---|---|
| 2 top arch bars | 3/16-in. | 2 suspension spring hanger clips* | .. |
| 2 bottom arch bars | ½-in. | | |
| 2 transoms | ½-in. | Bolster. | |
| 2 stirrups | 1-in. | | |
| 2 tie bar separators | ⅝-in. | 2 channels | ½-in. |
| 4 arch bar fillers* | .. | 1 center plate | ⅝-in. |
| 4 brake hanger carriers* | .. | 2 side bearings | ½-in. |
| 1 dead lever fulcrum* | .. | 1 center brace | ½-in. |
| 2 suspension spring hangers* | .. | 1 k.-pin supp'rt stirr'p | ½-in. |
| | | 2 spring plates | 1-in. |
| | | 2 end tie plates | ½-in. |

*Malleable iron.

This truck, for cars of 100,000 lbs. capacity, as illustrated in Fig. 8, weighs 1,615 lbs., including the bolster. It is made by the Schoen Pressed Steel Co., of Pittsburg, Pa., and the makers state that it is in extensive use.

## Metal Bolsters.

Besides the various all-metal trucks now being introduced there are numerous designs of metal bolsters, which can be adapted to present forms of trucks, either in new construction or to replace wooden bolsters in trucks now in service. Such bolsters are in very extensive use, some of them being manufactured by makers of metal trucks and other railway supplies, while many railways are using metal truck and body bolsters designed by their own mechanical officers. Several metal body bolsters were illustrated in our issue of July 2, 1896, in connection with an abstract of a report on metal underframes for freight cars, made by a committee of the Master Car Builders' Association, and we note below a few examples of the numerous designs of truck and body bolsters now in use:

The American Bolster.—This bolster, shown in Fig. 9, is a single casting of soft open hearth steel. It is an inverted trough, with fish-bellied sides and closed ends, openings being left in the top table to reduce the weight and the corners being strengthened by ribs. On the top table are formed the center plate and side bearings, while on the outer face of each side are formed the lugs or ribs which serve as the column guides. With the truck bolster is used a cast-steel body bolster with inclined lower flanges, forming a truss shape, and having a horizontal top plate riveted to it. On the lower flange are cast lugs of inverted T section, forming the shoes of the side bearings. The truck and body bolsters are both shown in Fig. 9, which also shows the American all-metal truck already described, and all three are manufactured by the American Steel Foundry Co., of St. Louis, Mo.

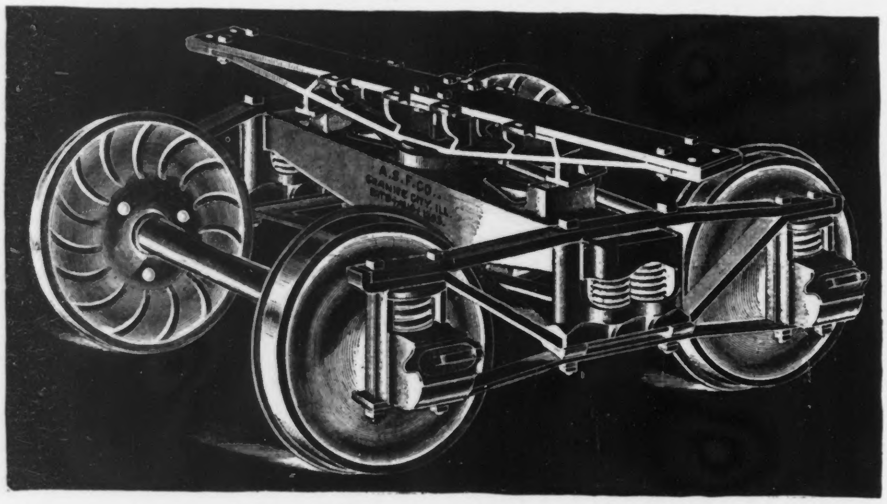

FIG. 9.—AMERICAN BOLSTER AND TRUCK.

The Bettendorf Bolster.—This is built up of I-beams which are subjected to an interesting process of manufacture. At each end of the web a portion is cut out, and the lower part of the beam is then pressed up by special machinery, forming a buckled rib, with a dovetailed joint at the end of the bolster. Malleable iron end plates, center braces, side bearings and center plates are then riveted on or secured by hollow lugs on the castings which pass through the holes and are beaded over, thus eliminating rivets. The Bettendorf bolsters for the Cudahy company's beef cars, shown in Fig. 10, have the truck bolster formed of two 10-in. I-beams, and the body bolster of two 8-in. I-beams, the weight of the bolsters being about 450 lbs. and 350 lbs., respectively. These are made by the Bettendorf Axle Co., of Davenport, Ia., and are among the specialties of the Cloud Steel Truck Co., Old Colony Building, Chicago.

The Marshall Bolster.—These truck and body bolsters are built-up trusses. The truck bolster consists of a cambered 12-in. steel channel, 35 lbs. per ft., with flanges downward, forming the compression member, and a plate ⅝ × 10 ins., passing under a king post at the middle of the bolster, and having the ends turned up over the ends of the channel and riveted to them. This plate forms the tension member. The truss depth is 12¾ ins. At each end is riveted a malleable casting on which are the column guides, and the center plate, side bearings and king post are also of malleable iron. The weight of the bolster, complete, is about 565 lbs. The body bolster has a horizontal top plate, with the ends bent over around the ends of the inclined bottom plate, a malleable iron filler being riveted between the plates, and the malleable center plate and side bearings being riveted to the bottom plate. The bolsters were designed by Mr. W. H. Marshall, Assistant Superintendent of Motive Power of the Chicago & Northwestern Ry., and have been applied to a large number of cars. They are being introduced by the Simplex Railway Appliance Co., of Chicago.

The Shickle, Harrison & Howard Bolster.—Cast steel is used for this truck bolster, which is a single casting, of rectangular section, but deeper at the middle than at the ends, and having openings left in the top and bottom tables to reduce the weight. The ends pass under the arch bars of the truck frame, and have cast upon them the ribs which form the column guides, but the center plate and side bearings are separate parts, riveted to the bolster. This bolster is shown in Fig. 11, and is manufactured by the Shickle, Harrison & Howard Iron Co., of St. Louis, Mo., who have already equipped 50 cars with it.

## INSPECTION AND TESTING OF MOTORS AND CAR EQUIPMENTS.*

By Frederick B. Perkins.†

I have thought it expedient for the purpose of setting forth my views on inspection to describe the work as being carried on in a modern car house containing 50 equipments. In dealing with the inspection of cars in this car house, we believe better results can be obtained by giving to each man some particular branch of the work rather than assigning to him a certain number of cars and expecting him to do all the work required thereon.

In this modern car house five repair men will be required, besides the foreman of the car house, whose duties in connection with handling of motormen and conductors, sending out cars and similar work, would require so much

*Condensed from a paper read at the annual meeting of the American Street Railway Association.

†Electrical Engineer, Toledo Traction Co., Toledo, Ohio.

of his time that he could only have a general knowledge of the work of inspection in the car house. Two of this number would be required to grease and inspect the motors; one to keep the controllers in repair; one to take care of the trolleys and to assist in the care of trucks and car bodies; one to have charge of the trucks and car bodies.

The most vital parts of the equipments are the different parts of the motor, viz., armatures, fields, bearings, brushes and brush-holders. The care of this part of the equipments should come under the head of greasing; and on the manner in which this part of the work is done depends, to a large extent, the frequency with which the cars will break down while in service; and also the amount of repair necessary to keep them in operation. Oftentimes the most ignorant and cheapest men are given the place of greasers. On the contrary, it is a position where intelligence and thoroughness are imperative.

The car should pass into the greaser's hands the first day after it is on the road and every second day thereafter. He should examine thoroughly brushes, brush-holders, gears, pinions, bearings and commutator. Of these parts, the care of the bearings and commutator is the most important, and should therefore receive the greatest amount of attention. The manner of caring for the bearings is very simple. They must be well supplied with grease or oil, and care must be taken that they are kept free from dust and grit, and also that the grease feeds properly.

In the matter of the care of commutators, electricians seem divided in their opinion as to whether they should be sandpapered or not; personally, I am not in favor of it. Instead of temporizing the commutator by sandpapering it, and thereby simply putting it in shape for one more day's work, I would get at the bottom of the trouble, and either make a commutator by some preparation of mica and copper which will not spark, or if the trouble lies deeper, remedy it by remodelling the entire motor.

I think, however, that usually the trouble is not in the commutator, nor with the motor, but in either the brushes or brush-holder, or both; and it is probable that with proper adjustment, and with proper care and treatment, we should find the trouble obviated, and sandpapering of commutators unnecessary.

The writer has personal knowledge of a large road where common brushes were used without any treatment or care except to replace as needed, and it seemed as if the man who used the most brushes was given the credit of taking the best care of his motor. The average life of brushes on this road and the above conditions, with the commutator sandpapered every day, was six days. Subsequently the sandpapering was stopped entirely, and the brushes were removed every six days and properly treated in oil. The life of brushes under this treatment was increased from six days to from forty to sixty days. The trouble with commutators, which had before been great, was reduced to a minimum; in fact, almost entirely averted.

Not less than every fourth day every controller and switch comes under the notice of the man who has charge of those parts. The main point is to clean thoroughly, using a little vaseline on the contacts. The parts that are worn should be touched up with a file or should be sandpapered, and if badly worn, should be replaced, so that at least every fourth day the controllers will be sent out in first-class condition. This man can also examine the car wiring, lamp fixtures, headlight, and all similar parts.

The fourth man will have the care of the trolley poles and wheels. These should be carefully looked over each night and oiled if necessary. The man who attends to this part of the equipment will also have considerable time to devote to general inspection of the car bodies and trucks under the direction of the general inspector. Under the scrutiny of these two men should come all the details of a car body, such as grab-handles, window-catchers, curtain fixtures and similar parts.

Concerning outside inspection, it may be a good plan to have it, but I do not believe it is desirable to have a large force. Very little of the time devoted to this line of inspection is really used in looking over the equipments, but must necessarily be consumed in getting from one car to another and in waiting for opportunities, and most of the troubles located by these inspectors are not of such a nature as to require immediate attention; and if they were the inspector could not make the necessary repairs without taking the car to the car house. Troubles of a serious nature, such as would require immediate attention and taking the car out of service, should be easily detected by the motorman or conductor, and reported at once to the proper official.

Taking up next the matter of testing, all materials purchased, such as tape, mica, etc., should be tested to keep it up to the standard. The testing room should be a separate department, and preferably should be partitioned off from the rest of the repair shop. For testing instruments I would advise the following:

A high and low reading direct current volt-meter; one having a double scale reading from 1 to 750, and from 1 to 15.

A direct current ammeter reading from 1 to 100.

A low reading ammeter would be very convenient many times, but is not absolutely necessary.

A 50,000-ohm magneto bell, an alternating current voltmeter and some handy testing set will make an outfit of instruments with which we can do all the testing required.

If the alternating current is not within reach of the car house, we must procure a small dynamo and produce it ourselves. A very small machine, say 2 HP., would be sufficient for all the needs of the testing department. If this machine is designed for about 100 volts, it would be most convenient for our use. With a few small transformers wound for 2,000 volts primary and for either 50 or 100 volts secondary, we are prepared to furnish any voltage within a range of from 5 volts to 10,000 volts.

The man who has this part of the work in charge can very easily and cheaply arrange the detail of installation of the wiring, etc. He can also make some resistance coils and many other pieces of apparatus which will greatly facilitate the quick testing of whatever may be sent to this department.

The testing room should examine and pass upon all supplies for car house or repair shop, and should issue instructions for the treating of brushes, adjustment of trolley poles and many similar questions. Enough samples of finished material should be tested to make sure that the standard of workmanship is being maintained, and armatures, fields, controllers, etc., should be tested to determine their ability to stand the electrical strains which will be placed upon them.

## PRODUCTIONS AND TRADE OF PORTO RICO.

The U. S. Bureau of Statistics has just issued a brief general description of the Island of Porto Rico that possesses interest to many capitalists and engineers looking in that direction for investment or employment. As summed up by the Chief of the Bureau, Porto Rico is a delightful winter resort, a valuable tropical garden and an important strategic point. But it has an area smaller than that of the State of Connecticut, or about 3,760 sq. miles.

Under the conditions of long settlement and dense population, most of the available soil is now under cultivation, and the prospects are not flattering for any material increase in its productiveness. The valleys and coast lands are now well occupied by sugar estates; the adjoining inland area is devoted to tobacco, and the mountain sides, to the very peaks, are covered by large coffee plantations. Only one-fifth of the population live in cities and villages; and the large rural population is of extremely simple habits and wants little that we can send them in way of food, clothing, furniture, etc. The small earning capacity of the people, in a depreciated currency, limits the consumption of imported goods.

From the standpoint of the engineer, it should be said that there are only 150 miles of railway and 250 miles of good roads on the island; and these are generally along the coast line; the military road across the island, between Ponce and San Juan, being the exception. Most of the interior is reached by bridle paths over which transportation is effected by packs on small ponies. In the cities and towns traffic is carried on with bullocks and primitive two-wheeled carts. While the towns generally lack water-works, lighting plants, drainage, etc., the conditions are not such as to demand such modern conveniences, and, as a rule, the people are too poor to pay for them. Only about one-fifth of the population is able to read and write, and though a kind of public school system prevails in some cities and towns, it is not of a high order. There are about 400 miles of telegraph lines, and several of the leading towns have some telephones.

According to the latest statistics available, the exports of Porto Rico amount to about $15,000,000 per year at gold value, and the imports to $16,000,000. Coffee forms 60% of the value of the exports; sugar, 20%, and tobacco, 5%; the remainder is made up of cocoa, rum, hides, sponges, cabinet woods, etc. All of the coffee practically goes to Europe, as the growers assert that they can obtain higher prices there than in the United States; and the reduced duties to Spain encouraged export to Spanish ports. About 50% of the imports are manufactured articles, largely cotton cloth, shoes, fancy goods and household articles; rice accounts for 15% of the imports; fish, 10%; meats and lard, 10%, and flour 7%. Naturally, most of these articles come from Spain, as the duties collected were only one-tenth of those charged imports from other countries.

As to prospects for investment, the Bureau of Statistics states that coffee plantations are now held at high prices; or $75 to $200 per acre, in Porto Rican money, according to location, quality of coffee and age of trees. Sugar plantations are relatively still higher in price, because of the more expensive machinery required; and many plantations have lately been abandoned and turned into cattle ranges. Tobacco has been lately very profitable owing to the shortage in Cuban tobacco; but the continuance of this profit is thus uncertain. Tropical fruits have received little attention from either local exporters or American investors, but they might prove more profitable than the other interests discussed, as they would be ready for shipment before the Florida or California fruits come upon the market in the United States.

Any increase in the production and consumption of the island will largely depend upon improvements made in harbors, roads and transportation facilities generally; and here is the opportunity for a combination of engineering with capital in this development. But it should also be remembered that no useful coal deposits have yet been found upon the island; fuel is, consequently, high in price, and the water-power is not to be relied upon, though streams are abundant.

## A PLAN FOR THE SAFE MOVEMENT OF ELECTRIC CARS ACROSS A WEAK BRIDGE.

For several years past an attempt has been made to run a trolley line across the Navy Yard bridge, in Washington, D. C. This structure was built in 1876 by Clark, Reeves & Co., of Phoenixville, Pa., and it is made up of twelve through Pratt trusses, each 100 ft. long, with a plate-girder bascule draw-span of 32 ft. Each truss has seven panels, with Phoenix columns and cast-iron boxes at panel points. Superficially the iron-work is still in fair condition. On Sept. 3, 1897, Mr. C. B. Hunt, M. Am. Soc. C. E., Engineer of Bridges of the District of Columbia, made a careful examination of this bridge, and declared it to be of insufficient strength for heavy electric cars.

In investigating the members he assumed a permissible unit stress 25% higher than that used in the original design. The weight of the motor-car was assumed at 30,000 lbs., on a wheel base of 7 ft. 6 ins.; the unloaded motor-car weighs 15,000 lbs., and it was assumed that 100 passengers, weighing 150 lbs. each, could be crowded upon it. The following results, for some of the main members and floor-beams, were obtained under the condition of two of these cars meeting each other on the bridge:

| Member. | Unit stress, lbs. per sq. in. Actual. | Permissible. |
|---|---|---|
| Trusses: Stirrup (shear) main floor beams | 4,640 | 6,250 |
| Flange ⅛-web added | 20,000 | 15,000 |
| Web (shear) | 5,680 | 6,250 |
| First truss vertical | 12,100 | 11,250 |
| Draw-span: 6-in. I-cross beams, flange | 27,000 | 15,000 |
| Flange, main girder, ⅛-web added | 19,900 | 15,000 |
| Web (shear) | 2,400 | 6,250 |

It should be noted that all flange unit strains are for tension on the net section, deducting rivet holes; and that, owing to the very shallow tram rail used on the draw, no assumption was justified that a wheel-load would be distributed to more than one of the 6-ft. cross-beams, which are spaced 2 ft. apart. The only live load assumed was that of the loaded car; and as the members considered were all details, limited to one panel of load, it was thought that the motor-car would practically represent the maximum loaded condition of the bridge.

After the investigation by Mr. Hunt the Capitol Railway Co. employed an engineer to examine and report upon the bridge. This engineer declared the structure to be safe, but he recommended some slight change in details. As a final result the Capitol Railway Co. has now obtained a permit to construct a double track trolley line over this bridge. But it is provided that a single overhead inverted wooden trough shall be built on the center line, and in this two wires will be strung. A small carriage will run upon these wires and a flexible cable from it will convey the current to the motors on the car. This arrangement, it will be seen, absolutely prevents more than one motor car crossing the bridge at a time.

As the cars on one side of the bridge are operated by an electric conduit system, while those on the other side have the overhead trolley, the change of current collecting system to cross the bridge will not be so serious a matter as might be supposed at first sight.

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The four elevated electric railways of Chicago, or at least the three now in operation, are generally conceded to be well built and efficiently operated, and they perform an excellent service in affording rapid transit to the remote borders of Chicago. But as business ventures they do not pay. The Metropolitan West-Side Elevated Railway is in the hands of a receiver; the Alley Elevated company has been reorganized, but is not paying dividends, and it is doubtful whether it ever will; the Lake Street road has fallen into the hands of Mr. Yerkes, the chief owner of the surface railways of Chicago; and the Northwestern Elevated is not yet completed and work upon it is at a standstill. The chief reason for this failure of four well-conceived business ventures is interesting outside of Chicago; and it is to be found in the recent rapid evolution of surface railways, from horse-cars to cable and overhead and underground trolleys, with a great increase in speed and a more convenient service to the average traveler. When the Chicago elevated roads were first projected, the greater portion of the outlying districts of that city was still dependent upon the horse-car service, and the prospects seemed very bright for any system of transit which would reduce the time of travel between the business center of the city and these outlying districts. Under these conditions the elevated companies were organized, the lines were built, electric traction was adopted, and large dividends were confidently looked for. But the projectors were unfortunate enough to strike a transition period in the development of surface traffic. The rapid introduction of the trolley system in place of horse cars on the surface roads in all the outlying sections of the city completely wrecked their well-laid plans. There is no question as to the speed and excellence of service on the elevated roads, and they seem to be efficiently managed. But the point to be made, and one that must be carefully considered everywhere by the projectors of elevated or underground systems of rapid transit, is that the mass of the traveling public will prefer surface roads whenever these even approach modern standards of speed and quick service. With this system there are no stairs to be climbed and the traveler can stop nearer to his destination; in fact, it is the nearest and most accessible route of travel from one point to another, and though the surface line may be somewhat slower, this fact of proximity will settle the question of choice of route with the great majority of people using city railway lines. In our older cities, where narrow streets prevail and surface travel is liable to congestion; or in cities where the natural conformation is such that the line of travel is largely in one direction, there is doubtless room for profitable elevated or underground roads. But even under these conditions the surface lines are serious competitors. It is no longer, as it was when the New York elevated roads were built, a question of steam or horse flesh. It is a question of competition between trains on a costly elevated or depressed structure and electrically-propelled surface cars, with almost equal speed possibilities and a much less costly and much more accessible roadway.

Including stops, the elevated railways are now able to make only 11 to 15 miles per hour, and the electric surface roads, in the outlying sections, where stops are not frequent and streets are not crowded, often do nearly as well. Under these conditions it is clear that we have about seen the end of elevated railway construction, except in some cases where peculiar local conditions occur, as, for example, the crowded streets of Boston, or the long-distance traffic up and down Manhattan Island.

The death of Hon. Thos. M. Cooley takes away a man to whom the country owes a debt of gratitude for faithful public service in a position of the greatest responsibility, but where few understood or appreciated the value of his work. When in 1887 Congress enacted the Interstate Commerce law and provided for a permanent commission to undertake its administration, every one conversant with public affairs realized that a most critical period had arrived in the relations between the railways and the public. The Interstate Commerce law was a necessary measure; but it contained some unwise provisions. A narrow-minded adminstration of the law might have inflicted serious injury upon railway companies and have made the law itself so unpopular as to open the door for its repeal, and thus postpone indefinitely the progress toward better relations between the railways and the people. When President Cleveland appointed Judge Cooley as the first Chairman of the Interstate Commerce Commission, he probably selected the one man in the whole country who was the best fitted to fill that post. He was not only an eminent jurist, and a man with a broad knowledge of business methods and public affairs; but more important still, he was one of the soundest and ablest living students of railway economics and of the relations of the railways to the public. The good which he accomplished, in educating the public, on the one hand, to appreciate the rights of the railway corporations, and railway officers on the other, to understand the necessity and rightfulness of Government control and supervision of railway operations, can hardly be overestimated. The Commission of which he was a member had herculean tasks to perform. It was expected to accomplish the impossible, and was criticised because it did not do it. For four years Judge Cooley labored at the head of the Commission, and then his health gave way from overwork, and was never afterward restored. He sacrificed himself for his country's welfare as truly as any soldier who meets death on the battlefield; but the great and patriotic service which he rendered during those four years of toil can hardly be overestimated.

In the discussion upon the status of the engineer corps in the Navy, it has been sometimes urged by line officers that there is no need of placing men of technical education in charge of the engines; but good practical machinists would meet every requirement. Experience in our recent naval operations furnishes good proof of the fallacy in this view. A recent press dispatch quotes the Russian naval attache at Santiago as expressing the opinion that, aside from gunnery, one of the greatest weaknesses of the Spanish ships was in the engine rooms. The Spanish navy, like the French navy, has no commissioned engineer officers, and the engines are run by machinists. The condition of the machinery of the Spanish vessels, and especially the torpedo boats and destroyers, is testimony of the defects of this system, in the stress of war. The Russian attache is said to ascribe the remarkably few breakdowns on the American vessels to the care and supervision exercised by the commissioned engineer officers in charge.

We congratulate the city of Baltimore upon the final outcome of the long controversy which has been waged there over the proposition to construct a system of municipal electrical subways. As announced on the first page of this issue, the ordinance for the construction of this system has finally been approved. In our issue of Jan. 28, 1897, we discussed editorially the reasons why the municipal ownership of subways for electric wires is desirable, and we shall not renew the discussion now. We may remark, however, that the happy outcome of the long agitation in Baltimore is due, in a considerable degree, we believe, to the work of one young engineer; and it is a remarkable illustration of what an able and conscientious engineer can sometimes accomplish in leading and guiding public opinion. Some years ago the city of Baltimore took the first step in the direction of municipal subway construction by building a system of subways for its police telegraph and electric fire alarm wires. The Chief Engineer of the Commission which performed this work was Mr. Nicholas S. Hill, Jr., M. Am. Inst. Elec. E. After this work was completed, Mr. Hill was made engineer of a Commission charged with the duty of investigating the problem of putting all the wires in the city underground, and he prepared for that commission a report in which the economic as well as the technical aspects of the subject were exhaustively discussed, and strong ground was taken in favor of municipal construction and ownership. We think it entirely probable that the final outcome in Baltimore is to be ascribed in no small degree to the able and convincing arguments which Mr. Hill presented in his report, and which we doubt not he has followed up in verbal discussions with those responsible for determining the city's policy.

It is one of the compensations which a conscientious engineer occasionally finds that though his work may be hard and his pay for it inadequate, it is often his privilege to play a large part in molding public affairs, and to wield a strong influence toward securing "the greatest good for the largest number."

## METAL TRUCKS FOR FREIGHT CARS.

The introduction of steel as a substitute for wood has been a very notable feature in railway freight car construction within the past few years, but the greatest advance in this direction is being made in the trucks rather than in the car bodies. The construction of cars with steel underframes and steel bodies has been the subject of much consideration by railway mechanical officers, and has been the subject of reports by committees of technical associations and of many articles in the technical press. While steel frames and steel bodies are in use to some extent and are likely to become even more general, for reasons which we have previously discussed, yet the process of introduction is but slow in comparison with the increase in the number of cars with ordinary wooden frames and bodies. On the other hand, there is now evident a very strong tendency towards the elimination of wood in truck construction, and all-metal trucks are now being used and introduced to a greater extent than is probably realized, even by railway officers, unless they have paid particular attention to the matter. The general experience with the ordinary style of truck is that wooden bolsters, even if trussed, are not strong enough for modern cars, and that wooden bolsters and wooden spring planks have to be constantly renewed. Mr. A. M. Waitt, of the Lake Shore & Michigan Southern Ry., informs us that while in his experience this is sometimes on account of decay, in most cases it is on account of these parts being too weak to stand the strains put upon them. In metal trucks, however, he has found that it is very rare that any

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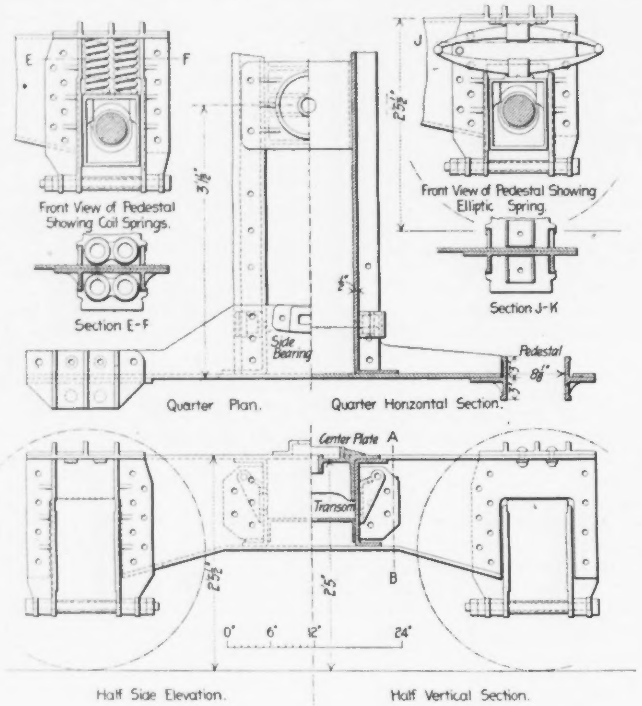



FIG. 2. CLOUD TRUCK.

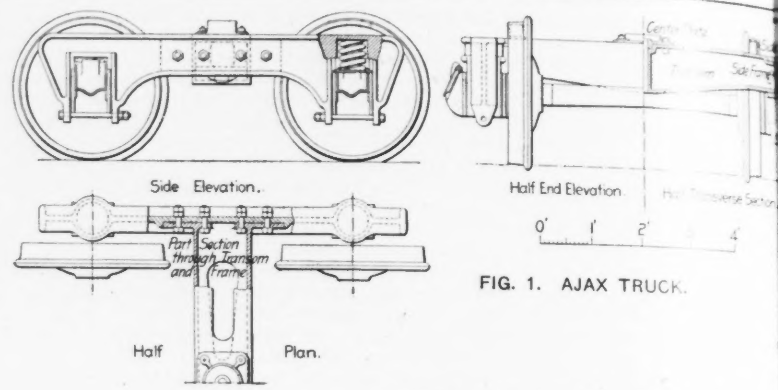



FIG. 1. AJAX TRUCK.

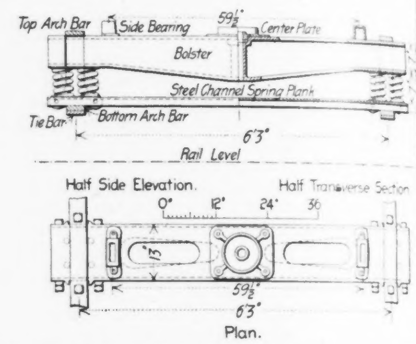



FIG. 11. SHICKLE, HARRISON & HOWARD BOLSTER.

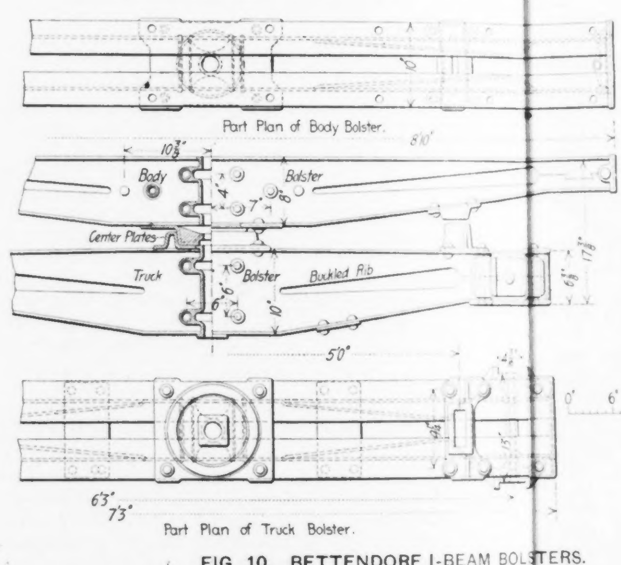



FIG. 10. BETTENDORF I-BEAM BOLSTERS.

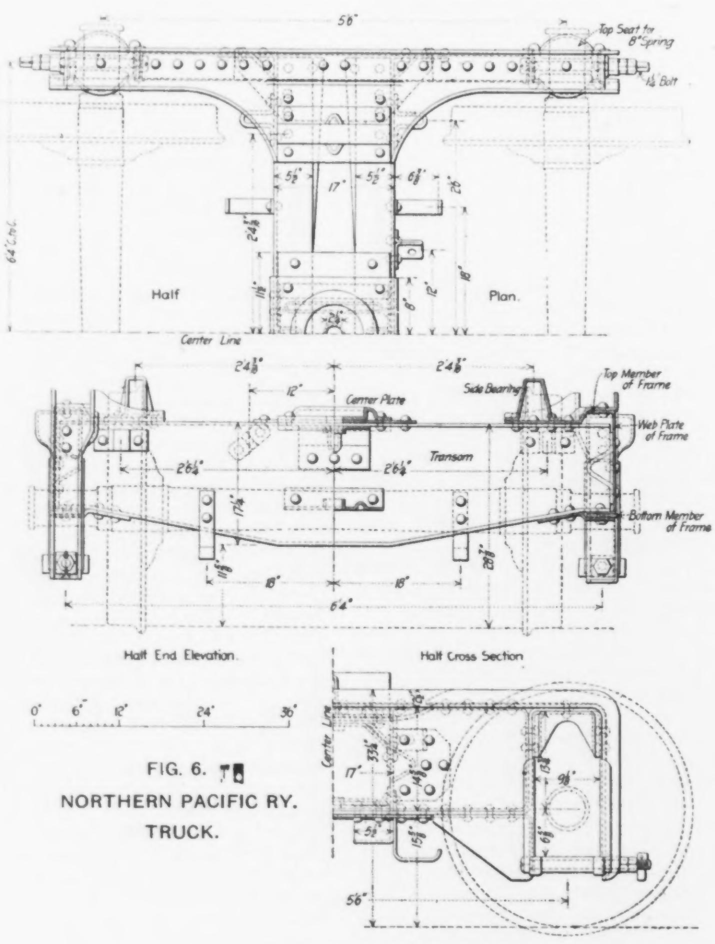
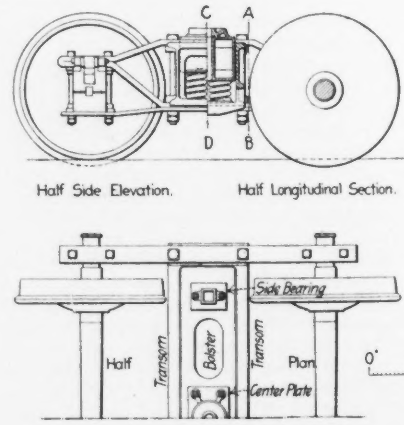



FIG. 6. NORTHERN PACIFIC RY. TRUCK.



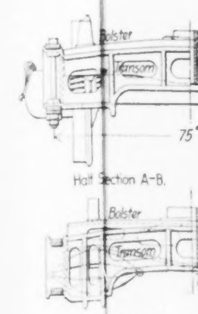




FIG. 7. PLA

METAL TRUCKS FOR FREIGH

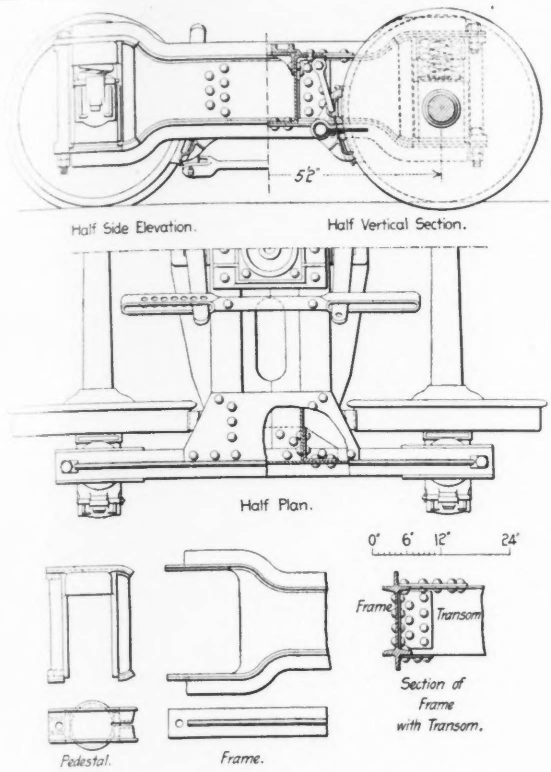



FIG. 3. HEWITT TRUCK.

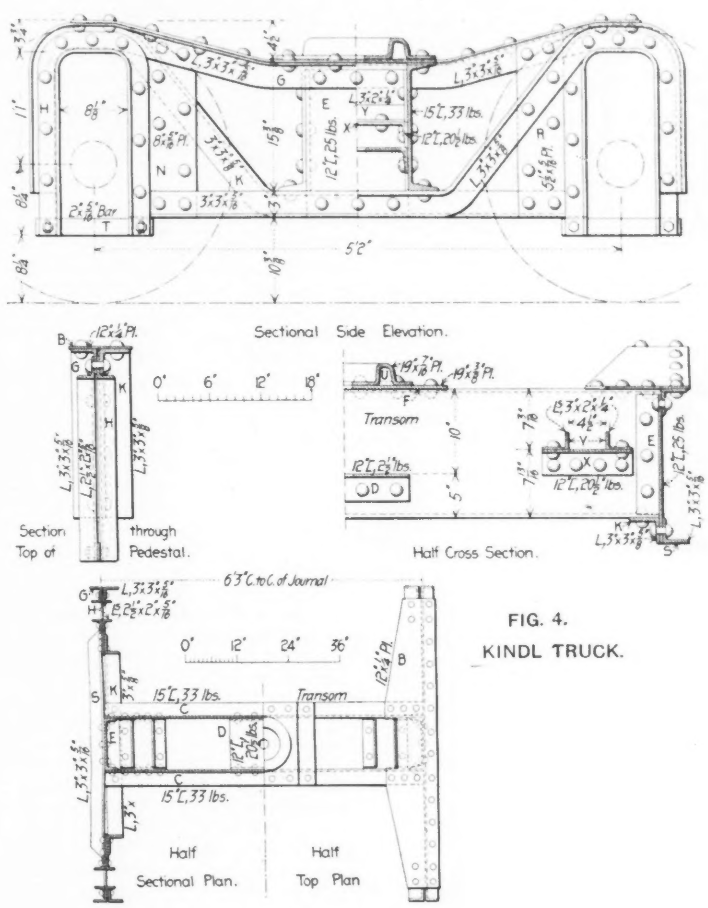



FIG. 4. KINDL TRUCK.

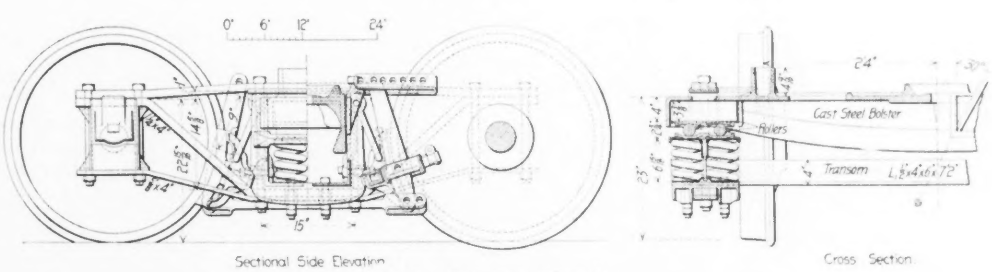



FIG. 5. SCHOEN TRUCK.

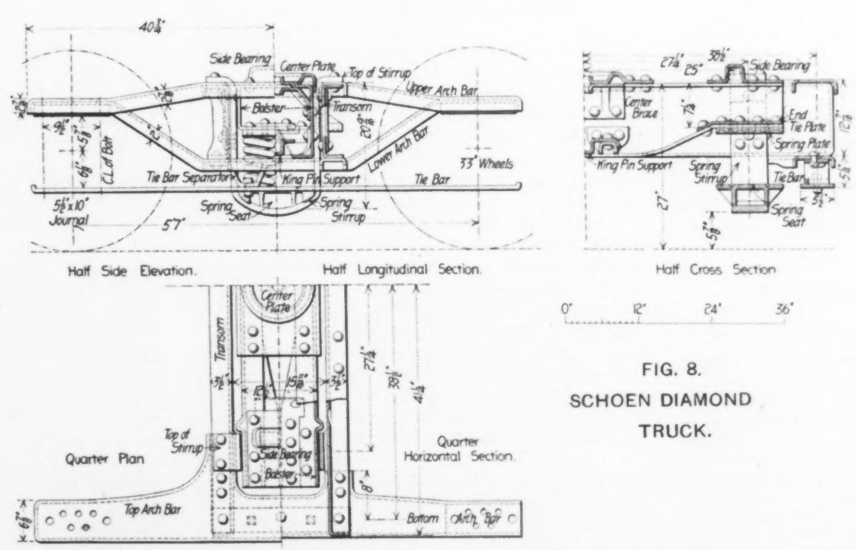
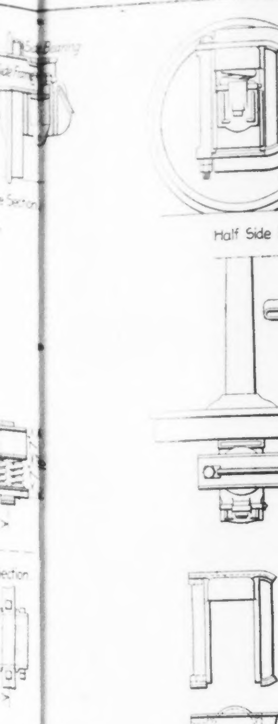
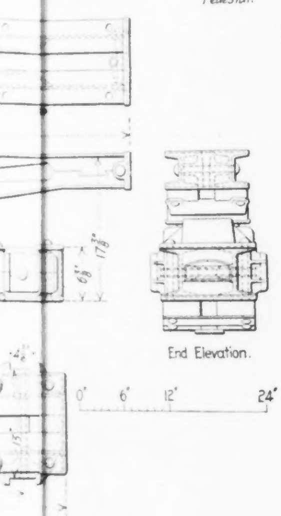



FIG. 8. SCHOEN DIAMOND TRUCK.



D BOLSTER.



BOLSTERS.

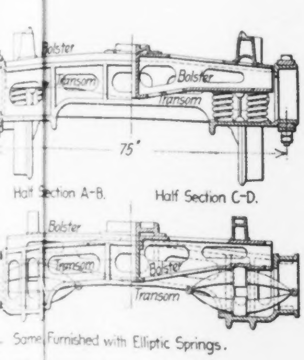



FIG. 7. PLAYER TRUCK.

FOR FREIGHT CARS.

parts have to be renewed, if the trucks are carefully designed.

The metal truck dates back about 35 years, but its general introduction on a commercial scale only began about six or seven years ago. The Boston & Albany R. R. introduced a metal truck about 35 years ago, and this proved very satisfactory and economical, but after some years it was abandoned, for the reason that under the conditions of car interchange the road did not get the benefit of its own trucks. The cars would go to foreign roads and then be sent from one road to another, making most of their mileage on foreign roads, which reaped the advantages from the small cost for repairs of trucks. In the meantime, the Boston & Albany R. R. was operating on its line the cars of other lines, fitted with the common form of truck, and after paying the extra cost for a more economical truck it still had about the same expenses for truck repairs. While the abandonment of this metal truck was unfortunate from a technical point of view, and also probably from an economical point of view, as metal trucks soon afterwards began to come into general use on other roads, yet it was no doubt warranted by the apparent financial results. The cost of a pair of these trucks (inclusive of wheels), was about $300, or considerably more than that for ordinary trucks, but, as already noted, the economical advantages due to the good construction were not reaped by the owners.

In 1891, the Fox pressed steel truck, which was an English invention, began to be introduced in this country, and it speedily attained great success. For some years it had the field practically to itself, but competition soon began. As the metal truck grew in favor, the number of designs of metal trucks rapidly increased. At the Master Car Builders' convention of 1895, it was stated by Mr. Higgins, of the Lehigh Valley R. R., that there was then about 90,000 pressed steel trucks in use under freight and coal cars, usually of 60,000 lbs. capacity. Since that time, however, the introduction of steel trucks has been very rapid.

The principal advantages of the metal truck may be given as follows: (1) Decreased weight, with corresponding increase in proportion of paying load of the car; (2) Less cost for repairs and maintenance; (3) Kept in square permanently; (4) Easier riding; (5) Fewer parts. The first of these is not embodied in all trucks, and in others the difference is too small as to be of much practical value. In still others, however, the difference amounts to 1,800 lbs. per car, which is certainly a very important saving. The second advantage is probably the most important as far as direct and evident economy is concerned, and on this point there is very little dispute. As long ago as 1893, a Committee on Freight Car Trucks of the Master Car Builders' Association reported that of 39 replies to a question as to the cost of maintenance of wooden and metal trucks, 29 stated that the cost was less with metal trucks. The committee considered that with a good design of metal truck the cost of maintenance would be 18% less than that of the best design of wooden truck. If we compare these costs for the repairs of the frames alone, the metal truck will probably show even more favorably.

In this connection it may be stated that we learn from Mr. B. A. Hegeman, Jr., General Manager of the Lackawanna Live Stock Transportation Co., that one of the company's stock cars is mounted on two Baines trucks, built entirely of iron, which have been in service since May, 1893, or for about five years, and are now in perfect condition. The expense for repairs has been remarkably small, and during 1897 the only expense (exclusive of wheels) was $1.88 for one journal box. This company has the Baines truck under 251 cars, and they have been running since September, 1888, making an average mileage of 3,000 miles per month. Mr. Hegeman states that if it were not for the higher first cost he would have the new trucks built entirely of metal, but that wood is even now only used for the sand planks. As to the fifth point, the reduction in number of parts, this is very generally held to be of great importance, and in 1895, Mr. G. W. Rhodes, of the Chicago, Burlington & Quincy R. R., called the attention of the M. C. B. Association to the fact that some metal trucks were being designed without regard to the principal reasons which led to the introduction of the metal truck; namely, decrease in weight and decrease in number of parts. Of course this view is not universally held, and it is to be noted that at least one type of metal truck—that of the Schoen Pressed Steel Co.—is purposely built up of a large number of parts. For this system of construction the claim is made that it will facilitate repairs at railway shops, as damaged or bent parts can be cut off, straightened or repaired, and again riveted on (or replaced with new parts), instead of sending to the manufacturer for an entire new frame or to have the frame repaired.

When we consider the character of the equipment of modern railway shops, however, and the small percentage of trucks that are damaged, this particular advantage claimed for the use of a great number of parts appears to be open to very grave doubt. This view was expressed very emphatically at the December meeting of the New York Railroad Club by Mr. A. E. Mitchell, of the Erie R. R. Since the spring of 1891 this road has used the Fox trucks on all new freight cars, and by the end of 1897 it had them under 6,815 cars. Of these 13,630 trucks there were only 75 failures, for which the railway company was responsible; 32 were sent to the manufacturer to be repaired, the average cost of repairs being $28.21 per truck; 43 were repaired at the railway shops. The latter repairs were effected without any formers, presses or other special appliances, the work being done in the boiler shops, over the flange fires, or in the smiths' shops with regular forges, the cost averaging $5.32 per truck. As all the trucks were derailed, he thought the expenses would have been much greater if the trucks had been of the diamond pattern. Mr. Mitchell considered that if all the cars on the Erie R. R. had Fox trucks, he could dispense with 50% of the truck repair men, exclusive of those engaged in repairing wheel and axle defects. As to the increase of weight in metal trucks, this is in part due to the increase in car capacity and the necessity of strengthening the body and truck bolsters so as to sustain the heavy loads without deflection.

With regard to the materials of construction, metal trucks may be divided into five classes, as follows: (1) Pressed steel; (2) Combination of special bolsters and other parts with frames of the ordinary diamond pattern; (3) Commercial rolled sections; (4) Special rolled sections; (5) Cast steel. Examples of all these are described elsewhere. Pressed steel trucks are the most numerous, with the combination diamond trucks coming next. It is claimed that the use of pressed steel enables a truck to be built which is lighter than and fully as strong as one built of commercial rolled sections, as the parts can be formed to the best shape adapted to mechanical and economical advantages, while with structural shapes the design must be adapted to certain fixed forms, with an almost inevitable excess in metal and weight. For the latter, however, the claim is made that a railway company can build or repair its trucks from material purchased in the open market, while pressed steel parts must be ordered from the manufacturer of the truck. We know of but one truck—the Hewitt—in which a special rolled section is used for the frames, but while the truck itself appears to have certain advantages, yet the difficulty of procuring special sections just when wanted is of necessity an objection. This has already been experienced with the truck in question, the manufacture having been delayed by the failure of rolling mills to furnish the special section ordered until several weeks after the required time, in consequence of having larger and more important orders on hand. The use of cast steel throughout is also confined to one truck—the Ajax—although cast-steel bolsters and transoms are used in a number of trucks.

A very important feature in truck design is the arrangement of the springs. In the ordinary diamond-frame type of truck, and in some others, the springs are under the ends of the bolster, leaving the weight of the truck frames to be supported rigidly by the axle boxes. This arrangement is in use in the majority of cases. In most of the pressed steel trucks and in some other forms of all-metal trucks, the springs are placed upon the axle boxes, no bolster then being used, but the center plate resting directly upon the transom. This appears to be the better arrangement from a mechanical point of view, since the entire weight of the car and trucks (except that of the wheels, axles and boxes) is supported by the springs, thus ensuring an easier riding car. One objection to this latter arrangement, however, is the difficulty of getting springs of sufficient strength and elasticity in the small space usually available, the springs being as a rule placed in the center line of the frame, and the web of the frame being slotted to receive them. In a report on springs for freight car trucks, presented to the Central Railway Club at its January meeting, it was stated that in diamond-frame trucks the space available for the springs is about 7 ins. high and 11 ins. wide for 60,000-lb. cars, and 9 × 11 ins. for cars of 70,000 lbs. capacity and over, while in pedestal trucks the available space is practically 7 × 7 ins. for 60,000-lb. cars, and 8 × 8 ins. for 90,000 to 100,000-lb. cars. The committee, therefore, recommended nests of four single-coil springs for diamond trucks, and double-coil springs for pedestal trucks. In the Cloud truck, however, this objection does not exist, nests of springs being used over each axle box, the web of the frame not being cut away for the springs, but passing between the inner and outer pairs of springs. With this arrangement any capacity of spring can be used, although the long and satisfactory experience with the Fox truck appears to show that the arrangement of a double-coil spring over each box is sufficient if properly designed. This arrangement was used in the old metal trucks of the Boston & Albany R. R., which have already been referred to, and in similar trucks used at the same time on the Boston & Maine R. R., and New York, New Haven & Hartford R. R.

One other point to which we may refer, is the proposition to divide the load on the truck between the center bearings and side bearings, instead of concentrating it all upon the center bearing. This latter plan, which is now universal, necessitates very heavy body and truck bolsters, especially under the modern cars of high capacity. Even with such heavy construction, however, and with metal bolsters (unless these are made very heavy) it is found difficult to keep the car bodies from coming down in contact with the side bearings. When thus in contact, the trucks cannot swivel freely, and after being slewed on a curve the trucks will often fail to return to proper line, thus causing excessive rail wear and a large proportion of sharp-flanged wheels. A recent suggestion is to adopt for the side bearings a roller or ball bearing which will not be liable to get out of order, and then to let the car body rest on the three bearings. This would seem to be a rational arrangement, but the practical objections are many, among them being the difficulty of keeping roller bearings in such condition as to be absolutely free acting, and the liability to overload these bearings where heavy freight is placed at one side of car. This question was discussed in our issue of May 26, and it seems likely to be brought to the practical consideration of car builders before long, in view of the increase in car capacity, and the consequent increase in the weight and size of bolsters, together with the desirability of reducing rather than increasing the weight of the trucks.

## LETTERS TO THE EDITOR.

### "Practical Man" vs. Engineer.

Sir: For the benefit of your readers, and to show what an estimate is sometimes placed on an engineering education and years of experience in the profession, I will narrate a little episode that came under my personal notice recently.

An engineer was engaged some time ago to prepare plans and specifications for an electric lighting and waterworks plant for a small town in the central part of Ohio. He did the work and bids were advertised for in your valuable journal; but a week prior to the letting he resigned for some reason unknown to the writer, and consequently the council felt that it was necessary to appoint a substitute immediately, so that they might have the advantage of his advice and experience before the contracts were awarded. Consequently the Clerk of the Council was instructed to take a copy of your paper and write to a few of the engineers who had cards in your columns.

He picked out five, and several other names were obtained from various sources. These gentlemen were invited to give bids stating what they would charge to superintend the work during construction and make some alterations in the plans and specifications.

Five engineers put in bids and three of them made two trips to the town in question to make themselves known to the members of the Council and forward their several interests as much as possible. The bids for engineering services were opened and read, and amongst them was one from a plumber who had been brought in from a neighboring town.

After the bids were read, the gentlemen present were asked to come up one by one and state their experience in the branches of the profession under discussion. Those present complied, the plumber having the last call. He stated that he had had 15 years' experience as a practical plumber, and would spend his whole time on the ground and give his whole attention to the work in hand for the sum of $150 per month. With regard to the engineering part of the work, he thought that the only thing necessary in that line was to have a surveyor set a few stakes at various times, which he thought could be done for $25 at the outside. The Council then went into executive session, and soon afterwards called the plumber in and told him that he had been appointed. For a couple of hours afterwards he sat with the Council, presumably to give his advice as to which contractors should have the various parts of the work. Fancy a plumber discoursing on the merits of the different makes of dynamos, arc lamps, pumps, boilers, engines and the various other details of the system!

Let us be thankful, however, that there are a few people in the country who can appreciate the value of an engineer's experience and who are willing to give a fair compensation for his services.

Yours very respectfully,
An Engineer.

(An excellent illustration of the deficiency of the so-called "practical man" as a professional adviser was recently brought to our attention, and may be appropriately told in connection with the above letter. A large printing establishment, designed to be a model in every way, was built a few years ago directly on the banks of a large river. The power-plant for this establishment was of considerable size, and the exhaust steam from the engines proved a great nuisance. The proprietor of the plant appealed to his "chief engineer," the man in direct charge of the engines and machinery of the establishment, as to what could be done to get rid of it. The man was a good example of the so-called "practical" man. He had had many years' experience in the care of engines and boilers; but the best thing he could suggest was the purchase of a long line of pipe, which was laid along the river banks, so that the steam was discharged into the atmosphere at some distance from the works, drifting back toward them, however, when the wind was in a certain direction. It chanced that an educated mechanical engineer came that way, and to him the "practical man" told the story of the difficulty. "But why didn't you put in a condensing engine?" said the engineer. And then it transpired that the "practical man," who had spent the better part of his life as a stationary engineer, had never heard of a condensing engine, and of the fuel economy resulting from its use wherever a supply of condensing water can be had. Doubtless this is an extreme case of the ignorance of the so-called "practical man" of everything outside the very limited sphere in which he has always moved, but it is instructive as showing what losses an enterprise may suffer through a failure to appreciate the value of the services which a competent consulting engineer might render them.—Ed.)

## COMPARATIVE MERITS OF SINGLE-TRUCK AND DOUBLE-TRUCK CARS FOR CITY RAILWAYS.*

By Richard McCullough, St. Louis, Mo.

Double trucks for electric cars are of comparatively recent adoption. All of the early electric cars were equipped with single trucks, and in this, horse car and cable car practice was followed.

Double trucks were first applied to cars in the desire to use longer bodies than has been customary. In the use of a single truck the best practice has been to limit the wheel base to about 7 ft., as a greater distance than this would cause the wheels to bind in curves. Assuming that the body of the car is 20 ft. long and that the platform projects 4 ft. beyond the body, the end of the platform would overhang the axle 10½ ft. This is as great an overhang as is customary, although single truck cars have been built with bodies longer than 20 ft. In this case it is necessary to provide extension springs on the trucks to check the oscillation of the car body. With a very long car body, however, the oscillation is not entirely overcome by this device, and the rocking becomes very disagreeable to passengers and very disastrous to the car and track. 22 ft. may be arbitrarily established as the limiting length of the body of a single truck car, and if we wish to use car bodies longer than this, we must adopt some truck which will avoid oscillation and which will pass around curves without undue use of power. The double truck accomplishes this, and it was to enable longer bodies to be used that it first came into use.

The truck which was first used for long street railway cars was an adaptation of that used by the steam railways. This truck contains four wheels of equal size and is pivoted over the center. It was soon discovered that for street railway use this form of truck has two very objectionable features, first, that the floor of the car must be high enough above the rail to allow the wheels to swing freely under the car, and, secondly, the motor being geared to one axle of the truck, only half of the weight of the car was available for traction. The latter is a serious objection on roads having steep grades.

From what has been said it will appear that the single truck is the truck for short cars, and the double truck is the truck for long cars. Therefore, a discussion of the relative merits of these two types of trucks will involve a discussion as to the relative merits of short and long cars. Also, as it is customary to supply long cars with

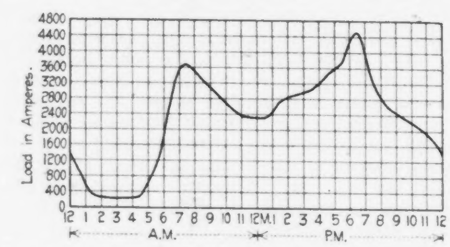



Fig. 1.—Typical Load Curve of Power Station of a City Street Railway.

cross seats and short cars with longitudinal seats, we have, instead of the comparatively simple subject of Single Trucks versus Double Trucks, which has been assigned to your committee, the more complicated struggle between the short car with single trucks and longitudinal seats and the long car with double trucks and cross seats.

It will be assumed in the discussion which follows that the road possesses the characteristic city travel, a load curve of which is shown in Fig. 1. It will be noted that two very pronounced peaks occur in this load curve, one in the morning from 6 to 9 o'clock, and the other in the evening from 5 to 7. It is at these times that the capacity of everything is tried. While the load curves of all city roads resemble each other, it is evident that local conditions will to a large extent determine the kind of car which the railroad company will operate. Some of these local conditions are, the class of people who constitute the passengers, the location of the road with reference to the established lines of travel, the amount of pleasure travel received by the road, and the keenness of competition with other roads.

The expense of the average city road may be divided up as follows:

| | |
|---|---|
| Maintenance of way and structures | 4% |
| Maintenance of equipment | 7% |
| Conducting transportation | 52% |
| General expense | 8% |
| Fixed charges | 29% |

It will be noticed that the item "conducting transportation" is more than one-half of the total. This is largely made up of the wages of conductors and motormen, and is proportional to the number of cars operated. Hence, it follows that if we may by the operation of larger cars cut down the number of cars, this account may be reduced in nearly the same ratio as the size of the car is increased. There are many other reasons why the size of cars has been increased, such as the increased volume of traffic due to the higher speed and enlarged territory of the street railroads, the greater comfort demanded by the traveling public, the increased power available for the operation of cars, etc., but it is probable that the present tendency toward the increased size of car bodies is with a view of operating larger units and fewer of them.

A line operating small cars seating 28 persons, on a headway of 3½ minutes, would give the same service from a standpoint of seating capacity if it operated large cars seating 40 persons on a headway of 5 minutes. Manifestly this latter service would be preferable from the railroad standpoint for the reason just given, and the question is, would the service be equally acceptable to the passenger. In this comparison we are assuming that the larger car is the more desirable vehicle in which to ride. Would the pleasure of the ride compensate the passenger for the greater length of time which he would have to wait? This is a question which must be solved by each manager for his particular road, as its correct solution depends largely upon local conditions over which he has no control. The scrutiny with which a passenger chooses a street car varies with the length of his proposed ride. If the ride is to be short, he takes the nearest car without reference to comfort; but if he is to ride a long distance he will walk past several lines in order to choose that one on which he will have the most pleasant ride. The car question then becomes a more serious one with long roads and with roads catering to a pleasure traffic. It has usually been accepted that on those roads having a purely business traffic, the proper car is the short one operated on short headway. The author, however, is of the opinion that even in this case, the long car operated upon somewhat longer intervals would be desirable. It has often been observed that where a line operates two sets of cars a passenger will allow several cars to pass him in order to patronize that type of car which suits him best. This has been observed even in the busy hours of night and morning, when it would be fair to assume that passengers would be hurried and likely to take the first car which passes.

One of the most serious questions occurring in street railway practice is the problem of how best to take care of the rush of travel which comes morning and evening. With our present methods, there are only two ways of taking care of this travel; the first, by increasing the number of cars or units in service, aud the second, by increasing the capacity of each unit. The latter method consists in attaching a trailer to the motor car, aud where this is done it is usual also to increase the number of units in service. On first thought there would seem to be no better method of increasing the capacity of a road thau by the use of trail cars. They are easily attached and detached, they are in service only wheu uecessary, and they do not require the assistance of additional trainmen. An examination of the trailer system, however, will reveal the fact that it possesses serious defects. The trailer requires the services of men and horses to attach it to the cars and to move it between the car sheds and the motor cars. The opening between the motor and the trail car increases the danger of accident both to passengers and conductors. The number of entrauces and exists is increased, and this augments the work of the conductor in keeping track of his fares and increases the danger of his missing some of them. If an extra conductor is placed on the trailer to collect fares, a great portion of the gain due to the trailer system is lost. The use of trailers throws an additional strain on the motors, as a heavy weight is added to the train which is not available for traction. The trouble is intensified as the load on the trailer increases; it makes the train more unwieldy in handling, and is largely responsible for the difficulty in starting and stopping quickly and in making schedule time.

To obviate the necessity of using trailers, a large car equal in seating capacity to the combined capacity of the motor and trail car may be operated. This system, however, introduces the disadvantage of the operation at all times of the day of a seating capacity needed only during a few hours of the day. It also increases the size and weight of the cars and the average power required to operate them.

In order to compare the relative economies of single and double truck cars, their advantages and disadvantages will be discussed with reference to the following points:

(1) Wear and tear on trucks.
(2) Wear and tear on motors.
(3) Power required.
(4) Wear and tear on track.
(5) The use of trailers.
(6) The seating arrangements and convenience of exit and entrance.
(7) The preferences of passengers.

These relations will, as far as possible, be reduced to a money basis, and in order to do so a comparison will be instituted between a road which operates double truck cars and one operating single truck cars, using trailers 26% of the time to take care of the heavy night and morning travel.

The bodies of the double truck cars are 26 ft. in length, and contain 18 cross seats, seating 36 passengers. The trucks are of the maximum traction type; the empty car weighs 23,500 lbs., and the motors are G. E. 800.

TABLE I.—Comparison of the Cost of Wheels and Brake-shoes on Double and Single Truck Cars for the Year 1897.

| | | Truck cars: Double (47). | Truck cars: Single (70). |
|---|---|---|---|
| Av. No. wheels used per car per year. | 33-in. | 8.72 | 6.26 |
| | 30-in. trailer | .... | 1.00 |
| | 24-in. | 7.06 | .... |
| Cost per car per year. | Wheels | $77.92 | $40.93 |
| | Labor in replacing. | 17.36 | 7.99 |
| | Brake-shoes. | 11.70 | 4.30 |
| | Total | $106.98 | $53.22 |
| Total cost per car, year, 1,000 psgrs | | $0.47 | $0.38 |
| Wheel mileage. | 33-in. | 17,260 | 25,329 |
| | 24-in. | 20,916 | ..... |

The double truck car has four 33-in. wheels, four 24-in. wheels, and eight brake-shoes. The single truck car has four 33-in. wheels and four brake-shoes. Average daily car mileage, 115.

*A paper read at the Annual Convention of the American Street Railway Association.

TABLE II.—Comparison of the Cost of Repairs and Maintenance of Trucks and Motors on Double and Single Truck Cars for the Years 1896 and 1897.

| | | Truck cars— Double (47). | Single (70). |
|---|---|---|---|
| Average passengers per car per year | | 226,000 | 141,000 |
| Truck repairs. | Per car per year........ | $181.00 | $110.00 |
| | Per 1,000 passengers. | .80 | .78 |
| Motor repairs. | Per car per year........ | 319.00 | 196.00 |
| | Per 1,000 passengers. | 1.41 | 1.39 |
| Total.... | Per car per year........ | $500.00 | $306.00 |
| | Per 1,000 passengers. | 2.21 | 2.17 |

G. E.—800 motors on double truck cars. W. P.—50 motors on single truck cars.

The single truck car has a body 20 ft. in length; it is equipped with longitudinal seats, and the entire car weighs 16,000 lbs. It will seat 28 passengers. During the period of heavy travel, which amounts to 26% of the time, trailers are attached to these motor cars. The average seating capacity of the unit, estimating the trailer as a part of the car during the time that it operated, is 35 seats, which approximates the seating capacity of the double truck car very closely. The motors in use on the single truck cars are W. P. 50.

The number of cars operated is obtained by dividing the daily car mileage by 115. It is necessary to do this because the average mileage per car on the two roads is different. The comparison is thus between 70 single truck cars and 47 double truck cars, each car making 115 miles per day. The road operating the double truck cars has the greater density of traffic.

Wear and Tear on Trucks.—It is evident that since a car equipped with double trucks has eight wheels and one equipped with single trucks has four, the former will be the more expensive to supply with wheels. Table I. shows the comparative replacement and cost of wheels and brake shoes on the two roads for one year. Table II. shows the comparative cost of maintenance and repairs of trucks and motors for two years. It will be noted that while the cost per car is much greater on the road using double trucks, the cost per passenger is the same. It would not be fair to assume from these figures that the cost of maintenance of trucks and motors per passenger is almost the same, no matter what sort of truck is used, because these figures would result largely from the fact that in this particular case the double truck car carries the greater number of passengers, but an inspection of the table will emphasize the advantage of the large unit as compared with the small one. It will be seen by a reference to Table I. that the greater part of the increased expense of maintaining the double trucks is due to the renewals of wheels and brake shoes.

In examining the relative strength of the various parts of trucks, the side pieces may be compared to a beam supported at two points and carrying a concentrated load. The deflection of such a beam is proportional to the third power of the span; and in the analogy, the span corresponds to the wheel base of the truck. Therefore, the shorter the wheel base the stiffer the truck side, and in view of its long wheel bases, it is evident that the single truck is at a disadvantage in this respect. For instance, a truck side where the wheel base is 4 ft. 6 ins. is 3.76 times stiffer than a truck side of equal section where the wheel base is 7 ft.

Wear and Tear on Motors.—Table II., to which reference has already been made, gives the comparative expense of inspecting, repairing and maintaining the motors of double and single truck cars. As in the case of the trucks, it will be noted that while the expense per car is much greater in the case of the double truck car, the expense per passenger is nearly the same.

TABLE III.—Comparison of the Power Required by Double Truck and Single Truck Cars.

| | Average watts. | Average watt-hours per car mile. | Average speed, miles per hour. | Average watts per seat capacity. | Average watts per ton (car empty). | Avg. watt-hours per car mile, 1,000 passengers. |
|---|---|---|---|---|---|---|
| Double truck car. Seats, 36; weight, 11.75 tons...... Average for the entire day........ | 12,040 | 1,334 | 9.03 | 335 | 1,025 | 5.9 |
| Double truck car. Seats, 36; weight, 11.75 tons...... Average for the heaviest trip...... | 13,080 | 1,412 | 9.25 | 335 | 1,025 | ... |
| Single truck car, no trailer: Seats 28; weight, 8 tons. | 8,471 | 921 | 9.20 | 303 | 1,060 | ... |
| Trailers operated 26% of the time ............ Average for the entire day .................. | 9,400 | 1,110 | 8.42 | 254 | 1,088 | 7.9 |
| Single truck motor and open trailer: Seats, 63; weight, 10.5 tons; average for the heaviest trip. ........................ | 12,680 | 1,440 | 8.84 | 201 | 1,208 | ... |

Table IV. gives the relative weights carried by the different cars, when empty, seats full and car crowded. It will be noted that while the percentage of weight available for traction in the case of the maximum traction truck remains constant, in the case of the motor and trailer it falls off as the number of passengers increase, and is especially small if the trailer is proportionately more heavily loaded than the motor car.

Power Required.—Table III. gives the power required to operate the different cars, and is the average of a long series of watt-meter tests. In making these tests, the watt-meter was placed on a car in actual service and allowed to remain through the entire day. An examination of the tables will reveal the fact that the power required for the propulsion of the car and the care and repairs which the motors demand are much greater in the case of the double truck car. But if the number of passengers be taken into account, it is seen that the power and the cost of maintenance are roughly proportional to the number of passengers carried with either style of truck.

Wear and Tear on Track.—The wear of the rails of a street railway track is due to the grinding action of the wheel on the rail, and this is proportional to the weight on the wheel, but is intensified by the dirt on the rail, which causes the wheel to slip and acts as an abrasive agent after the slipping has begun. The weak point of a street railway track, however, consists of the joints and the openings in the special work. The energy of the blow which the wheel strikes as it passes a low joint or a crossing is equal to the product of the weight of the wheel and the height of the drop. Therefore, on any given track both the wearing action of the wheel and the destructive action of the wheel are proportional to the weight which rests upon it. If the number of wheels under a car be increased, the number of blows which a low joint receives is also increased, but the intensity of each blow is diminished. Double trucks are at no disadvantage as compared with single trucks in this respect, unless the weight of the car be increased. By reason of the shorter wheel base, double trucks go around sharper curves and go around the same curve with less output of power and less wear on the rail than single trucks. The double truck fell into disrepute when the maximum traction truck was first exploited, on account of its liability to leave the track. This was due to the small amount of weight which was placed on the small wheels. It is now customary to place 30% of the weight on the small wheels, and with track in fairly good condition, no difficulty is encountered in keeping cars on the track.

The Use of Trailers.—In the case of the two roads under discussion, the road operating single truck cars attached trail cars to the motor car for two trips in the morning and two trips in the afternoon. For the entire year trailers were operated on 26% of the trips. Allusion has already been made to the use of trailers. The advantage of the trailer on this particular road arises from the fact that the load peaks are unusually sharp. The use of the trailer increases the capacity of each unit during the heavy hours of morning and evening travel and during rush travel due to baseball games and races. On this particular road the motormen and conductors are paid 10 cts. per trip extra for all trips where a trailer is attached to the motor car. This expense largely offsets the value of this arrangement. There is no question but that the use of the trail car increases the number of accidents, for two reasons; first, because the trailer is another car, and, second, because the opening between the motor and trail car is a dangerous one for a passenger boarding or alighting from the car. It is impossible to estimate the money value of this accident liability, because in the case of many accidents it is difficult to determine what proportion of the damage was due to the trailer. Trailers must be switched at the ends of the roads and at the car sheds, and require men and horses for this purpose. The use of trailers also entails other expenses, such as car heating, cleaning, repairing and car license, which should be charged against the trail car system. To counterbalance all these disadvantages, the only advantage which the trail car system possesses is its flexibility.

The Seating Arrangements, Exits and Entrances.—As has already been stated, the cross seat is used almost so universally in connection with the double truck car that it is fair to consider the economy and efficiency of cross seats and longitudinal seats in connection with the discussion. There is no doubt that the cross seat is preferable from the passenger's standpoint.

If two car bodies of the same size are taken and cross seats installed in one and longitudinal seats in the other, the car body equipped with the cross seats will have the narrower aisle. This induces two disadvantages in the cross seat car, one, that the crowded capacity of the car is less, and the other, that when the car is crowded the time consumed in loading and unloading is increased. The latter difficulty will be the more serious the shorter the haul and the greater the number of stops.

In the early days of the double truck car it was customary to mount the body high enough so that the wheels would swing under it. This gave the car a very unsightly appearance and made it difficult of access. Three steps were necessary to reach the platform, and as these steps were steep, this form of car was particularly objectionable to ladies. By the use of the maximum traction truck, with 33-in. wheels, however, it is possible to lower the floor to within 37 ins. of the rail. By dropping the platform 8 ins. below the floor of the car, it is possible to reach the platform by the use of a single step 14 ins. above the rail. This renders the car as easy of access as the single truck car. In the opinion of the writer, the fact that the car floor may be made so low in double truck cars is the chief advantage of the maximum traction truck.

It has been attempted to facilitate the loading and unloading of large cars by providing exits and entrances other than the rear door. This practice, however, brings about what is perhaps a more serious disadvantage, as it gives the conductor more than one door to watch, renders it difficult for him to keep track of his fares, and increases the liability of his starting the car before a passenger is on or off.

The Preference of Passengers.—The preference of passengers, to which allusion has already been made, is undoubtedly in favor of the double truck car. In cities where the entire street railroad system is controlled by one company this point may not be considered of value, because passengers are obliged to ride in whatever conveyance the company chooses to furnish. However, the experience of roads which have changed their rolling stock from small, single truck cars to large, comfortable, double truck cars is that the travel has shown an immediate increase.

Outside of the question of economy of operation, there are few roads on which the use of attractive, easy-riding, double truck cars would not create a pleasure travel, especially in the summer season. In a general way, it may be stated that the single truck car is more suitable for short hauls, dense traffic, many stops and low speed. On the other hand, the double truck car is more suitable for long hauls, high speed, few stops and pleasure travel. In the existence of either extreme condition, it would not be difficult to decide which car to use. It is in dealing with intermediate conditions that the manager must use his judgment.

TABLE IV.—Comparison of Weights Carried by Single and Double Truck Cars.

| | Single truck— Motor car. | Motor car with Open trailer. | Motor car with Closed trailer. | Double truck car. |
|---|---|---|---|---|
| No. of seats .............. | 28 | 63 | 48 | 36 |
| Total, crowded capacity.. | 80 | 140 | 125 | 110 |
| Weight, empty, lbs....... | 16,000 | 21,000 | 21,000 | 23,500 |
| Per cent. weight on driv'g wheels: Car empty. | 100 | 76 | 76 | 70 |
| Seats full ............ | 100 | 67 | 72 | 70 |
| Car crowded .......... | 100 | 67 | 71 | 70 |
| Weight per seat, lbs.: | | | | |
| Car empty ............ | 572 | 334 | 438 | 653 |
| Seats full ............ | 702 | 463 | 568 | 782 |
| Car crowded .......... | 943 | 622 | 776 | 1,050 |
| Weight per unit total capacity: Car empty.. | 200 | 150 | 168 | 214 |
| Seats full ............ | 246 | 210 | 218 | 258 |
| Car crowded .......... | 330 | 280 | 298 | 344 |

Note.—Each passenger is estimated at 130 lbs.

## COMMITTEE REPORTS AT THE ANNUAL MEETING OF THE ROADMASTERS' ASSOCIATION OF AMERICA.

The following are some of the committee reports presented at the annual meeting of the Roadmasters' Association of America, held at Denver this week. The remainder will be published in our next issue.

### Best Method of Preventing Creeping Rails.

It has long been known that rails do creep, but this shifting of position is not uniform, nor is it alike for both rails. In its most aggravated form, it is confined to localities and is due to local conditions.

Rails creep in the direction of the traffic on double track lines. This creep is found to be greater on down than on up-grades, and is found in its worst form where tracks have been laid over marshes or soft, yielding sub-oil; on single track it is most noticeable on down-grades and where there is a descending grade from both directions, the rails creep down and come together in the valley, causing the rails at the foot of the grade to buckle in hot weather as a result of the space between the rails which had been allowed for expansion, being all taken up. It has also been ascertained that on curves, the outer or high rails creep the more, and where there are successive reverse curves and especially on grades, the creep starts on tangent at approach, continues on high rail to the end of first curve, then the opposite high rail on reverse curve shows the more creep. In other words, the high rail on each successive curve is found to creep more than the low rail.

The cause of creeping track is because of a rolling load passing over it which depresses the track directly under it and produces a corresponding elevation and depression ahead and behind it, which may be likened to a wave motion. To illustrate this more clearly, reference is made to a series of experiments mapped out by Mr. F. A. Delano, Superintendent of Freight Terminals of the Chicago, Burlington & Quincy Railway, and under the supervision of Mr. Jas. E. Howard, of the Watertown Arsenal, a description of which appeared in the "Railway Review" of March 24, and 31, 1894, which is in part as follows:

Facilities were supplied by the C., B. & Q. R. R. for carrying on such tests. The time selected was during the month of October when the roadbed was as firm and solid as at any time during the year. The place was Hawthorne Yard, near Chicago, and a portion of the tests were made on the main line and others on sidings. The experiments consisted of measuring under locomotives of different weights, the depression of the rail. Two weights of rails were experimented upon, one weighing 66 and the other 75 lbs. per yd., the rails rested upon oak ties in all experiments; but some were supported by gravel and others by cinder ballast. The track selected was in good condition, the spikes being redriven before the work was begun. The ballast rested on hard, unyielding clay.

For the purpose of observing the depression of the rails, in one class of experiments, bench marks were established on a row of stakes driven alongside of the rail 31 ins. distant from it. A beam carrying a micrometer and an astronomical level bubble was used in observing the depression of the rail, first measuring the height, using a point on the outer flange, when the rail was unloaded, and repeating the observation when the locomotive was in different positions with references to this point, making the observations when the observed point was directly under each wheel, and when midway between them.

After a number of experiments had been conducted in this manner, it was discovered that the roadbed in the vicinity of the locomotive was sensibly depressed, and that the bench marks were influenced by the depressions. Careful measurements were made of this depression and it was found that at a point opposite the main driver of Class "H" locomotive, three-driver, connected with bogie truck, weighing 125,000 lbs., the depressions were as follows: At a point 31 ins. from the rail, 0.047-in.; at a point 61 ins. from the rail, 0.013-in; at a point 91 ins. from the rail, 0.001-in. This discovery revealed the necessity of establishing new bench marks, and in so doing a cantilever was used, having its support 10 ft. from the rail. On a track laid with 66-lb. rails and supported by oak ties, 17 to a 30-ft. rail, and in gravel ballast, the greatest depression under an engine weighing 110,000 lbs., was 0.161-in.; this was under the middle driver.

The same weight engine on the same kind of rail and ties, but supported by cinder ballast, the depression under middle driver was 0.230-in. From this it will readily be seen that there is a marked depression of the track under an engine, and when we consider that the same depression of the track takes place when the engine is moving as well as when at rest, it can readily be conceived what a destructive effect it has. With the track depressed under the weight of an engine, a corresponding rise just ahead of it to be afterwards depressed as the engine approaches and passes over it, produces a violent wave motion under high speed which is the cause of creeping rails. The outer rails on curves creep more than the inner rails, because of the lateral lever motion imparted to them by reason of the wheels hugging the outer rail more closely as a result of their cone shaped design which enables them to travel the greater while their mates travel the lesser distance in rounding a curve and because of the inclination of moving bodies to go in a straight line, which is overcome by introducing another force when the outer rail on curved track is elevated. The rails on outer edge of embankment on double track creep most because of less support than the rails near the center of roadbed. As the rails shove ahead they drag the ties with them, the only resistance being the amount and kind of ballast between them. If the track is well filled in the center but bare at the ends of the ties, another lever movement is introduced. The ballast in the center acts as a fulcrum, the tie becomes the lever and instead of moving ahead with the rail and retaining its corresponding position at right angles with it, the one end is forced ahead of the other, especially is this the case with joint ties, and more particularly where rail is laid with broken joint, with the added result of tightening the gage. Aside from this the ties are moved off their well tamped foundation on to the softer untamped bed between the ties, and if not closely watched and early corrected, the whole track will creep the more because of the looseness of the several parts, and then a general disintegration takes place, which will require several hard season's work to restore, the only means being either to draw the rail back and straighten up the ties, or else replace all of the ties to suit the new location of the rail. To do this requires as much if not more work than to make the tie renewals and surface the track.

It is doubtful if a remedy for creeping rails exists or can be found and we are none to sure that if stopped it would be only to reappear in another form. While it cannot be eliminated entirely, it is quite possible to restrict it so that in its effect it is not so destructive. The most common method is to rely upon anchorage at the joint by spiking the tie through slots in the angle bars. The value of this style of anchorage depends upon the number of ties over which the angle bar extends, which may be one, two, or three, and resistance is directly in proportion to the number of ties. In practice it is found that the three-tie joint affords the best anchorage, but it does not entirely prevent the rails from creeping. It is also found that by placing a dummy joint in the center of the rail opposite the joint, which may be made from old angle bars bolted to the rail and spiked to the slot, that additional anchorage is afforded. On some roads, specially designed dummy joints are made in clip form; these clips fit in the web of rail the same as an angle bar, but in addition extend under the base of rail like a lip chair, slotted on the inside and punched on the outside of rail for spikes, taking the place of a tie-plate as well as affording anchorage. Either of these forms give fair results.

Another method is to bolt a flat bar of iron inside the nut at joints, the bar to be twisted half around so that the tal end will be parallel with the rail and rest flatwise on the ties to which it is spiked through holes made in it for that purpose.

Still another method is to make a clip in two parts to fit snugly under the base of rail—a clip on each side, both to be united with a bolt underneath, these clips to come in contact with the edge of the tie, depending on the tie for resistance as in the other devices.

As creeping rails are the result of both vertical and lateral wave motion, the best remedy which suggests itself is to restrict that wave motion to a minimum, which can only be done by having a rail stiff in section to transmit the weight of the load over the greatest possible area of ties and ballast, to be well tied, with spikes kept snug to base of rail, and ballast dressed off as full as can be at the end of ties, and at the same time allow for drainage.

H. W. Church, Samuel Greer, John Redington, Committee.

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Advisability of Increasing the Length of Rails and the Advantages to be Derived from the Use of Rails with Miter Cut Ends.

Majority Report.—Rails of 45 and 60 ft. in length have been in use on a few railways in this country, mostly in an experimental way, for the last six to eight years. The only advantage which seems to have been developed during this time by their use is in the reduction of the number of joints. Some of their objectionable features are as follows:

1. Rail mills do not as yet appear to be able to turn out as straight a rail of 45 or 60 ft. in length as those of 30 ft.

2. Their contraction makes them more liable to flatten on the ends than rails of shorter lengths, and their greater tendency to creep makes it necessary to put on stops, which increase the expense and does not entirely prevent the creeping.

3. They are not as readily or as economically transported or handled when new, or when taken out for relaying, or for shipment when worn out, as those of 30 ft.

Miter cut rails have been to some extent tried from remote periods, and somewhat extensively so on some few lines within the last ten years or so, and the experience with them after this length of time has not been satisfactory, and they have been temporarily, if not permanently abandoned. The principal reasons for this are that they break at the ends where the head and web join, caused generally by the extension of one side of the head beyond the other, and the angle at which they have to be cut thus far shows that there is very little or no difference in the blow received from passing wheels, from those having square ends, and further, the flow of metal at the ends appears to be greater with the miter than square cut rails.

After giving these questions due consideration and from all the information obtainable, and from the experience we have, we do not at this time deem it advisable to recommend that there is enough advantage in increasing the length of rails beyond 30 ft., or to use rails with miter cut ends, to recommend their use.

R. Caffrey, Chairman.

Minority Report.—The use of rails of more than 30 ft. in length can be said to have passed the experimental stage, and the utility and economy in the use of rails 60 ft. long have been recognized by several important lines of steam as well as electric railways. The transporting of rails up to 60 ft. in length is no longer a difficult or unusual problem. From those who have used 60-ft. rails for a sufficient length of time to enable them to give reliable figures, your committee has endeavored to learn the cost per ton of handling and laying in track as compared with the cost per ton of 30-ft. rails, also to ascertain the peculiarities, defects and advantages in their use.

Through the kindness of an official connected with one of the largest Eastern lines, and one that maintains a high standard of track, we are enabled to give the result of their experience with long rails, some sixty miles of which has been laid up to the present time. This road commenced laying 60-ft. rails, experimentally, in 1894, and the result thus far has been so satisfactory that large orders have been placed for rails of the same length for further renewals. The advantages gained are, economy in handling, reduced cost of maintenance and better riding track. On level or moderate grades, stop blocks are not found necessary and are not used. On heavy grades and on unstable marsh grounds one to two stop blocks or anti-creeping devices are used on each rail. Cost of this appliance is 13 cts., and cost of putting it on is about 10 cts. each. The unloading of the rails on this line is done in a very simple manner and with a less number of men than is necessary to handle 30-ft. rails from cars in the usual way. A rope about 30 ft. in length is supplied with a hook at one end to anchor to the track, and at the other to hook through the bolt hole at end of a rail on the car. The hooks being in place the work train is started and the rail drawn nearly off. Eight men with rail tongs then lower the end of the rail as the car is pulled from under it and two men with bars throw the rail out of the track. In laying the rails in track, double the number of tongsmen and half the number of bolters are required that would be needed in laying 30-ft. rails. The creeping of long rails has not been found the serious matter that had been anticipated. The average saving on the road in question is fully 15% in handling and laying 60-ft. rails over the same number of tons of 30-ft. rails.

Through the courtesy of Mr. M. J. Caples, Assistant Engineer of the Norfolk & Western Railroad, we have information as follows as to results obtained from the use of 60-ft. rails on that line: They have 18 miles laid in winter of 1892-3, and 29 miles laid in 1894-5. The rail is 85 lbs. per yd., 5 ins. high and laid on grades ranging from 9% to 2.4% (47 ft. to 126 ft. per mile) and on curves as high as 16°, with about 40% of all the curvature over 8°, single track. Traffic over this piece of track averages four passenger trains and forty freight trains per day. Passenger engines, 10-wheel, with 98,000 lbs. on three pairs of drivers, and consolidation freight engines with 106,800 lbs. on the drivers. Ballast nearly all furnace slag. Joint fastening, "Churchill" patent 23-in. angle bar extending 3¼ ins. below base of rail between the joint ties, and a 7-16-in. plate of the same length as the angle bar. No stop-block or anti-creeping device is used.

After 5½ years' service under these conditions, Mr. Caples says of the 18 miles laid in 1892-3: "We have had no trouble whatever by reason of expansion from any of the 60-ft. rails. The ends have not been battered sufficiently to enable us to determine that it is greater than 30-ft. rails laid at the same time where the normal expansion distance has been preserved. There has been no greater tendency on the part of 60-ft. rails to creep than with 30-ft. rails." He adds that in his opinion a stop-block would be beneficial, and that battering of the ends consequent on creeping and expansion will make necessary the changing out during the present season of 130 rails (4%) of the 18 miles laid in 1892.3. The cost of unloading and laying in track has been 20% less than unloading and laying an equal number of tons of 30-ft. rails under the same conditions.

One complaint which is general, but not universal, is that rail mills send out 60-ft. rails without their having been properly straightened. It would seem that this is simply a question of mechanical skill, and the fact that some mills do straighten 60-ft. rails would bear out this view. If one mill can do it, all can be brought up to the same standard by a system of careful inspection before acceptance of rail.

After carefully considering all the information obtainable, your committee is of the opinion that the increase of the length of rails to 60 ft. is entirely practicable, and that the benefits to be derived are, a reduction of the cost of handling and laying in track, a reduction of 50% in the cost of joint fastening, if no stop-blocks are used, and of at least 25% if such a device is used, a reduction in cost of maintenance and better riding track.

The use of rails with miter ends, although not a new idea by any means, may be said to be still an experiment, and trials that have been made on several roads have been disappointing in some respects. It is certain that the principle is sound, that a diagonal opening between the rails, so adjusted that the tread of the wheel before leaving one rail engages the next, will relieve the joint from the blow incident to the passing of wheels from one rail to another over square cut ends. In 1894-5 a trunk line road laid three-quarters of a mile of 75-lb. 60-ft. mitered rails. These rails were cut at an angle of 45° and laid in single track, thus the points were facing on one side and trailing on the other. Joint fastenings, 34-in. angle bars, suspended joints. After 3½ years' hard service the joints are in excellent condition and the rails show no signs of wearing or battering at the ends. The officials who are interested and are watching this piece of track feel hopeful that the mitered 60-ft. rail is the coming rail.

In 1894-5 the Norfolk & Western Railway laid in single track, 29 miles of 85-lb. 60-ft. mitered rails, cut at an angle of 45°. Joint fastenings, "Churchill" patent. Traffic same as detailed in that part of this report referring especially to 60-ft. rails. During the 3½ years' service three or four mitered points on 29 miles of track have broken off. No trouble with wheels catching the points. The mitered rails on this road are not giving good satisfaction, as under the heavy traffic the joints are battering badly, and it is estimated that the rails will give not more than two-thirds the service of square cut rails under the same conditions.

In April, 1893, 16 miles of 75-lb. 4¾-in. mitered rail, cut at an angle of 55°, were laid trailing points on double track on the C., M. & St. P. Ry.; joint fastening, 30-in. angle bar, with six bolts, suspended joint. Traffic over it has averaged about 10 passenger trains and 10 freight trains per day. Passenger engines are 8 and 10-wheel, with 60,000 lbs. and upwards on three pairs of drivers; freight engines, standard and compound, with 84,800 lbs. on three pairs of drivers. By reason of crude or careless work in the mechanical part of the rail mill process, the rails were in bad surface when laid. One end of a large percentage of the rails were bent or dipped 1-64 to 1-16-in., apparently by having been thrust against a dog at the rail saw while hot, the ends not having been sawed simultaneously. The result was that in track, the mitered point being bent downward, the weight was thrown on the point, and some 60 rails in the 16 miles of track had 3 ins. of the mitered points broken off. Aside from this defect, the mitered rails make good riding track, and after five years and four months of hard service, show no signs of flattening or flowing at the joint; however, it can be said that neither does square cut rail laid at the same time and under the same conditions.

Good surface at joints is more easily maintained on mitered than on square cut rails. There has never been an instance of rail points slipping by or overlapping so as to form a lip.

The majority report of this committee shows unsatisfactory results obtained on the Lehigh Valley R. R. from mitered rails that have been in service about the same length of time as that on the C., M. & St. P. R. R. This rail was cut at an angle of 55° and laid with 30-in. angle bars, suspended joints.

In all the tests of mitered rails that have come under our observation, the rails have been laid without a tie under the joint, and with the exception of the N. & W. Ry., with no support for the base of the rail at the joint. Although the mitered rails, concerning which we have information, have not been in track long enough to fully develop the strong and weak points, from data obtainable your committee is of the opinion that much better results can be obtained by cutting the rails at an angle of 65° and using a tie under the joint, or a joint fastening that will give full support to the base of the rail. At an angle of 65° it is certainly not necessary to restrict the use of mitered rails to trailing points. No instance has come under our observation of any trouble with the rails cut at an angle of even 45°. Gurdon W. Merrell.

Latest Improvements in Frogs and Switches.

Your committee finds that there has been but little that may be considered new, and yet has had sufficient use to prove its value, introduced since the report of last year on this same subject. The spring rail frog and split switch continue in general use for main track work, and are constructed on general lines which are very familiar Special attention has been paid during the last year by designers and manufacturers to improving in detail the separate parts of these devices, in order to make a safer and more serviceable whole.

Frogs.—With spring frogs, the following details are carefully looked after:

(1) Anchor of spring rail or anti-traveling device. On plate frogs, this is accomplished by a link attached to a pivot on the plate and one on the movable rail. On frogs without bottom plates the spring rail is secured by means of an anchor block at the joint at the toe of frog bolted to both the fixed and movable wing rails of frog, or the spring rail is attached to plates fastened to under side of frog and spiked down to the ties. The spring rail should be so secured that the maximum amount of travel possible will not cause the spring rail to bind in either opening or closing.

(2) Holding down devices. These prevent vertical motion of spring rail and generally consist of pockets enclosing a lug which is fastened to the movable rail. These lugs are allowed a vertical play of not to exceed ⅛-in. and sufficient longitudinal play to prevent binding.

(3) Grooving of movable rail. The groove is parallel to gage line of main track side of frog, the outer line of the groove being 4¼ ins. from the gage line and inner line distant from gage by width of head of rail.

(4) Springs. The size and number of springs to each frog vary, as does also the location of the springs with reference to point of frog. The power of the spring should be ample to close the spring rail under all ordinary conditions, and should be placed as near as practicable to the center of that portion of the wing rail which fits up against the frog point. If a spring bolt is used, it should be of the best quality iron.

(5) Stops. Spring frogs should be provided with stops, which will absolutely prevent the spring rail from opening to any greater extent than the standard width of throat in a rigid frog.

(6) Heel Riser. Spring frogs, as well as all other main track frogs, should be provided with a heel riser of steel rail run back far enough so that combined width of riser and head of point rail will at least equal the width of tread of engine driver.

Rigid frogs, as their name implies, should be as substantial as possible. If of the filled, bolted pattern, the bolts should be 1 in. in diameter for rail from 4¼ ins. to 5 ins., and 1⅛ ins. in diameter for rails more than 5 ins. in height. If plate frogs, the bottom plate should be not less than ¾-in. thick, and the rails secured to it with ¾-in. rivets having a pitch of not more than 3 ins.

Switches.—The split switch, otherwise known as Clarke, Jeffery or Lorenz, is in general use throughout the country.

The general features of this switch are common to most roads, but there is a great variation in details. One of the features that has been discussed largely of late years is the number of tie-bars, and uniformity of practice in this respect has not yet been attained. While some lines show a tendency to increase rather than diminish the number of tie-bars, your committee is of the opinion that with splice switches 15 ft. long, properly re-enforced and provided with stop lug, two adjustable tie-bars are all that are necessary. The use of a wrought-iron plate extending through under both rails at the point of switch, with the ends fitted with rail braces, is an improvement that is becoming more general.

Slide plates should extend under the main rail and be heavy enough to keep from bending and should be fitted with a rail brace on the outside. Bolts and pins in connecting rods and tie-bars, except those fastening lugs to split rail, should be turned to exact size, be a neat fit, provided with nut and spring cotter, and as far as possible be of uniform size throughout the switch. We believe that the general practice is to make these bolts too small. While the essential features of the split switch are common to the switches in general use in this country, there are scarcely any two lines whose switches do not vary in some detail. Your committee believes that much greater uniformity in this respect is possible and desirable.

C. Dougherty, S. P. Adams, Peter Clark, Thos. McKune, E. H. Bryant, Committee.

Discipline, in Its Practical Application to Track Forces.

There are at this time two distinct methods of the application of discipline. The one which educates by regulations and special instructions, where the breach is regarded as an offense to be corrected by punishment which takes the form of reprimand, suspension and dismissal. The other, known as the "Brown" or "Fall Brook" system, which, according to the report read at the 27th annual meeting of the American Society of Railroad Superintendents, had at that time been adopted by 28% of the 180,000 miles of railway in the United States. In this latter system the educational feature predominates, the idea of punishment being entirely eliminated. Under it the employee is not subjected to fines and suspensions, but is judged wholly by his record, and is retained or dismissed accordingly as his record is good or bad.

Of each case requiring disciplinary action, a record is kept, and demerit marks are entered against the one at fault. All meritorious acts are likewise recorded and merit marks given. A given number of merit marks are cancelled by a like number of demerit marks, or vice versa. This gives an opportunity to retrieve a previous good standing. Further than this, each employee having a clear record for a given length of time, say six months or a year, is entitled to a certain number of merit marks, which emphasizes in a measure an appreciation of his service. It stimulates his pride and conduces to further effort to maintain his standing. At the end of each year the record is closed and a new one opened. All cases after being fully and fairly investigated are issued in bulletin form, omitting names, places, dates, etc., that there may be nothing to identify the individual with the bulletin. These bulletins point out the errors and consequences, and how they might have been avoided, that each may profit by the experience of his fellows. All meritorious acts are recorded and bulletined in like manner.

Abolishing from our minds the idea that discipline means punishment, but is purely educational, and bearing in mind that the success of any undertaking depends largely upon the skill of those engaged in it, the query naturally arises as to which of these two systems is the better as applied to track forces.

In the event of a suspension under the first-named system, it is necessary to put a substitute in charge, who, as a rule, is less skillful, lacks knowledge of the localities and conditions, and where the suspension is for a considerable length of time, the company would suffer because of this lack of skill and knowledge. The suspended employee would not only lose his time, with the consequent hardship entailed upon his family, but it causes him to feel a secret dislike for his superior and the company he serves.

With the "Brown" system, instead of the employee losing his time and his family being inconvenienced, if not immediately suffering by reason of his enforced idleness, a given number of demerit marks would be entered against his record. The company would be the gainer by his retention in the service, not having to educate a new man, with the possibility ever present of his making a still greater mistake. The retained employee would feel his error more keenly and would, I think, be less likely to err in the future, and so far as the others are concerned the lesson would be equally as good. H. W. Church.

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WIRE NAILS, says the "Iron Trade Review," have reduced the output of cut nails to less than one-fifth of what it was in 1886. About 40 years ago the United States annually produced about 2,000,000 kegs of cut nails, or about 89,000 tons; and in 1886 the maximum output was reached with 360,000 tons of cut nails. Until 1880 cut nails held the field; but in 1892 the wire nail output was the greater, with 4,750,000 kegs, as compared with 4,500,000 kegs of cut nails. This total of 9,250,000 kegs is the high-water nail output in any country at any time. In 1895 a maximum output of 5,841,000 kegs of wire nails was reached, while the output of cut nails for 1896 was less than 900,000 kegs. At the present time there are 79 wire nail factories operating in the United States, as compared with 53 in 1896. There are now 4,544 cut nail machines working, as compared with 4,598 in 1896. Cut nails have fallen in price to an average of $1.60 in the six years ending in 1896. Wire nails cost for small sizes an average of $10.90 per keg in the four years ending in 1880; while in the four years ending in 1896 the average was $3.62, and the lowest annual average was $2.93 in 1894. In standard sizes of wire nails the prices are lower; the average for 1887 was $3.15 per keg, and in 1896-97 prices fell to $1.60. But cut nails are cheaper still, the average for 1894 being $1.08 per keg of 100 lbs. This latter rate is equivalent to about $23 per ton, or little more than the English price for steel rails.

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THE PATENT ON THE JONES MIXER, an apparatus used in connection with the direct Bessemer process, has been adjudged valid by Judge Buffington, of the U. S. Circuit Court, at Pittsburg, in an infringement suit brought by the Carnegie Steel Co. against the Cambria Iron Co. The mixer patent was issued June 4, 1889, to the heirs of the late Capt. Wm. R. Jones, general superintendent of the Edgar Thompson Steel Works of the Carnegie Company. The mixer is a large covered vessel, lined with fire brick, holding 200 to 300 tons of molten iron. The pig metal is drawn from the blast furnaces into ladles, in which it is carried to the mixer and poured into it. At the same time the metal in the mixer is drawn off from time to time into other ladles, which carry it to the Bessemer converters. The mixer performs the double function of storage, enabling the converters to run regularly, while the rate of production of the furnaces is irregular, and, of mixing, by which variations in the quality of the iron received by the mixer from different furnaces are evened up, and the quality of the iron delivered to the converters is made practically uniform.

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THE COMBUSTIBLE CITY REFUSE OF BOSTON is to be disposed of under a contract made on Sept. 10 with the City Refuse Utilization Co., of which Mr. Herbert Tate, of New York, is president. The contract is for ten years, the city of Boston retaining the option of buying the plant under appraisement at the end of five years. The refuse is to be sorted and the worthless parts are to be destroyed by fire; and the compensation is a cash payment of $5,500 per annum by the city of Boston, the contractor reserving the right to all valuable material saved from the refuse. The firm of Jones & Meehan, of Boston, is now building the plant from plans made by Mr. W. F. Morse, M. E., of New York. This plant is to cost $29,000, and is to be completed in December next.

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THE SANITATION OF SANTIAGO, CUBA, under American control, is showing quick results. Gen. Wood, the Military Governor of this old and always unhealthy Spanish city, has divided Santiago into five sanitary districts, each under a physician, with inspectors of sewers, streets, houses and dispensaries, assisted by 100 street cleaners. About 500 cu. yds. of refuse are burned daily, disinfectants are distributed where needed, and a heavy fine is imposed for uncleanliness or failure to report cases of sickness or death. As a result, there is a marked decrease in sickness among the poor, and the average death rate has fallen from 70 to 20 per month. There is also decreased sickness among the new troops. The harbor is now the chief source of trouble, as the current is slight near the city. It is proposed to dredge the muddy shallows, protect the banks with stonework, or piles, and to carry the present infectious sewage two miles down the bay to a swifter current. Gen. Wood expects within another month to make Santiago as healthful as the ordinary Southern town in the United States.

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RAILWAY TICKET SCALPING is to be regulated—if not suppressed—by ordinances lately passed in Cincinnati and other Western cities. These provide that the ticket-scalpers shall take out a license and give bonds against selling spurious, counterfeit or stolen tickets. Cincinnati has lately arrested and fined eight dealers in these tickets for unlawful selling, and six others are in jail in that city. A number of railway companies have also recently made it a condition, in making reduced rates for conventions, etc., that the city where the meeting is to be held shall undertake to clear out scalping offices, which have been proven to deal in counterfeit or stolen tickets.

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THE CYLINDRICAL COTTON BALE is gaining in favor, and the American Cotton Co., John E. Searles, President, controls the system and has opened its commercial department in Nos. 11,12 Cotton Exchange Building, New York. This part of the company's business is in charge of Mr. John Martin. About 150 of the cylindrical compresses are now in operation; and the output is said to command a higher price than for cotton as ordinarily baled, as it is more compact, more symmetrical and practically non-combustible. The machinery is now perfected and the operations of the company are to be "aggressively extended."

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A RAILWAY IN HAYTI is proposed, extending from Cape Haitien to La Grande Riviere du Nord, a distance of about 18 miles to the northeast. The capital stock is fixed at $450,000, and the estimated cost is $250,000 for a narrow-gage road; the Haytien government is to guarantee 8% interest and the material is to be purchased in the United States. Mr. Henri Thomesset is the engineer, and the government grants to Cincinnatus Leconte and

Blanc Eusebe, the former being the present Minister of the Interior and Public Works, an exclusive privilege and concession for 60 years. The country traversed is a beautiful plain; adapted to the cultivation of the peculiar products of the island, and especially suitable for the growth of the banana. Mr. Lemuel W. Livingston, U. S. Consul at Cape Haitien, has forwarded the above information to the State Department.

HAWAIIAN RAILWAYS include the three following lines: The Kahului railway, 13 miles long, on Maui Island; the Hawaiian railway, 20 miles long, on the island of that name; and the Oohu Railway & Land Co.'s Line, running from Honolulu to Waianae, with a total length of 38½ miles, including sidings. The first two lines are chiefly used for carrying plantation products to shipping points. The last named line was opened in 1890, and in the year 1897 it carried 85,596 passengers, paying $30,993, and 66,430 tons of freight, paying $69,753. The equipment of this line includes 5 locomotives, 14 passenger cars and 132 freight cars.

PROGRESS ON THE TRANS-SIBERIAN RAILWAY, at the beginning of 1898, is reported as follows in the "Revue Scientifique." Commencing at Tcheliabinsk, the western terminus of the Siberian line, the railway is opened to normal traffic to Krasnoiarsk, a distance of about 1,347 miles. From the latter point to Klioutchinsk, 218 miles, the line is opened temporarily; and it will be definitely opened upon the completion of station and other necessary buildings. Beyond Klioutchinsk the rails are laid for about 20 miles, to Touloune; two bridges are to be built upon this section. From Touloune to Irkoutsk, 238 miles, and from Irkoutsk to Lisvenitchnaia on Lake Baikal, 40 miles, the roadbed is completed and nearly all the bridges and station buildings are finished. On Lake Baikal, the ice-breaker ferryboat which is to transfer trains from one bank to the other, is being erected, and it is expected that it will be finished in 1899. Surveys are still in progress for a line around Lake Baikal, but nothing will be done in constructing this road until the whole line is open. In the Transbaikal section the roadbed is graded and rails were laid between Strietensk and Mitrophanor, a distance of 200 miles; but the floods of last year carried away some of this track, and only 71 miles of rails were left in January, 1898. The eastern section is finished, the first train leaving Vladivostock for Khabarovsk on Sept. 15, 1897. The preliminary survey but not the final location has been made for the line across Manchuria.

A PER DIEM SYSTEM OF FOREIGN CAR RENTAL, devised by Mr. J. M. Daly, Superintendent of Transportation, Illinois Central R. R., is being tested, apparently with considerable success, by a number of Western railways. At present, as is well known, the general practice is for railways handling the cars of other lines to pay for their service according to the mileage made, regardless of the time consumed in making this mileage. It has been found that this plan results in a great many irregularities, one road perhaps paying its neighbor at the rate of 50 car miles per day, while it might receive from that neighbor payment based upon less than 20 car miles per day. Under the Daly plan the roads exchange car day for car day and pay mileage only on the remainder of days. The railways which have been testing the new plan are the Illinois Central, the Atchison, Topeka & Santa Fe, the Hocking Valley & Toledo, the Chicago, Milwaukee & St. Paul and the Missouri, Kansas & Texas, and at a meeting of the car service officials of these companies recently held in Chicago the following figures of foreign car service for July 1898, as compared with the same month of 1897, when the old mileage plan was in operation were presented by the committee having the experiment in charge:

| | 1898. | | 1897. | |
|---|---|---|---|---|
| | Days. | Miles. | Days. | Miles. |
| I. C. | 7,644 | 202,776 | 9,737 | 151,009 |
| C., M. & St. P. | 7,054 | 188,938 | 7,808 | 136,235 |
| Santa Fe | 4,584 | 141,104 | 4,626 | 102,985 |
| H. V. & T. | 201 | 3,205 | 202 | 2,044 |
| M. K. & T. | 1,336 | 49,975 | 1,347 | 54,322 |
| Totals | 20,819 | 585,998 | 23,720 | 446,595 |

According to this statement the average car miles per day increased under the Daly plan to 28.6 miles per day, against 18.8 miles per day under the old straight mileage plan, a gain of 52.1% or 9.8 miles per car per day. While it would be incorrect to conclude from these figures that the gain is due alone to the new system of paying for foreign car service, the experiment is an interesting one and should be carefully watched by railway traffic managers.

## THE BRIDGE DISASTER AT CORNWALL, ONT.

The fall of two spans of the New York & Ottawa R. R. bridge over the American channel of the St. Lawrence River, near Cornwall, Ont., was briefly reported in our last issue. The number of men killed in the accident is now given as 15, while 16 were seriously injured. At the time of the accident the erection of both the fallen spans had been practically completed, and under one the falsework had been removed. On the other span the workmen had begun to take down the traveler, but most of them were working on the floor of the bridge when the accident occurred.

Principal interest, of course, centers in the construction of the pier which went down with the two spans. The river at the site of the pier is about 35 ft. deep, and has a swift current, said to be about 5 to 8 miles per hour. The river bottom is a clay hard-pan in which are imbedded boulders, many of them of large size. The pier was founded by sinking a timber crib 18 ft. wide, 62 ft. long and 38 ft. in height, and filling it with concrete deposited under water by buckets arranged to empty automatically on striking the bottom. The anchoring and sinking of this large crib in the deep water and swift current was a task of great difficulty. To accomplish it a small crib filled with stone was sunk upstream to serve as an anchorage and a 3-in. steel cable was led from this to the pier crib, which was also supported by a barge on each side. Cables led to the river bank were used to swing the crib in the stream till it was in the correct position.

The swift current made it impossible to examine the bottom by divers before sinking the crib. Soundings were taken over the site of the crib, however, and the crib bottom was scored to correspond to the depth thus obtained.

After the crib was down divers went down inside and obtained samples of the bottom, which was deemed satisfactory by the engineer, and the work of concreting began. The first concrete laid, to the amount of about 50 cu. yds., was deposited in bags, all of which were placed by divers around the sides of the crib. The remainder of the concrete was then deposited from a bucket holding about 1 cu. yd. arranged to dump automatically on contact with the bottom. The concrete was deposited in successive layers of about 18 ins. over the whole area of the crib, and divers reported it as setting satisfactorily.

The concrete was mixed by hand in the proportions of 1, 2 and 5, using Glen's Falls Portland cement. It may be said here that the crib itself was built of 12-in. timbers, drift-bolted together, cross-ties of the same size were inserted at 10 ft. intervals, the vertical spacing being about 4 ft.

The concrete was carried up to a point 4 ft. below water level, and was then pumped dry, the top of the crib projecting above the water forming a coffer-dam. The top of the concrete appeared in good condition, and upon it the masonry was started. Two courses were laid and then work was shut down for the winter, all the above-described work having been carried out last fall. During the winter the pier was subjected to heavy ice pressure, which, as most engineers know, is a severe test of any pier built in the swift current of the St. Lawrence; but it was not moved. Early in the spring, we are informed, it was struck by a heavy timber raft, which was broken up by the collision, and the pier showed no injury.

Work on the piers was resumed in the spring and they were built up to their full height of about 35 ft. above the water, making the total height about 70 ft. from the river bed to the pier coping. The masonry of the piers was rock-faced ashlar, with a backing of Portland cement concrete.

The specifications and working drawings for the bridge were made under direction of Mr. F. D. Anthony, Chief Engineer of the New York & Ottawa Ry. Co., and were approved by Mr. A. A. Stuart, M. Am. Soc. C. E., now Engineer of the Degnon-McLean Construction Co., of New York city, who was consulting engineer to the railway company. They were also approved by the Canadian Government engineers.

The report has been widely published that a tugboat captain who witnessed the accident declared that he saw one of the spans break in two first

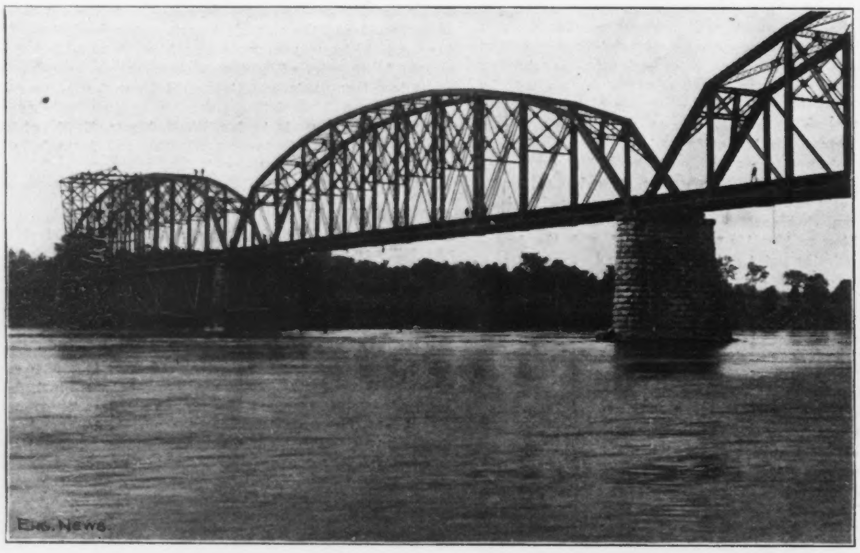


FIG. 1. THE NEW YORK & OTTAWA R. R. BRIDGE OVER THE AMERICAN CHANNEL OF THE ST. LAWRENCE RIVER, NEAR CORNWALL, ONT.

(From a photograph taken on the morning of Sept. 6. The two spans shown and the pier on the left fell at noon on that day.)


FIG. 2. VIEW OF WRECK OF THE NEW YORK & OTTAWA R. R. BRIDGE, LOOKING SOUTH FROM PIER 3.

(From a photograph taken on the afternoon of Sept. 6.)

and pull the pier over. Later accounts are to the effect that this man now says he was in the engine room when the accident occurred, and was not in a position to see whether span or pier fell first.

The accompanying illustrations, reproduced from photographs, will, we doubt not, be examined with interest by our readers. We may note that the north end of each span is in each case the fixed end. Thus on Pier 2, which fell, the channel span rested on expansion rollers, while the shore span, which still had the falsework under it, was anchored to the coping. The channel span turned partly on its side in falling, and its end-shoe is now about 25 ft. south of Pier 3, on which it formerly rested. The shore span carried the falsework down with it, and, falling into shallow water, made a tangled mass of wreckage, as shown in the illustrations.

Fig. 4 shows the masonry of Pier 2 just started. It will be noticed that it is located considerably to one side of the concrete base. We understand that this was made necessary to bring the pier in correct position, the crib being sunk a little to one side of its correct location.

The above comprises practically all the facts we have been able to obtain bearing upon the causes of the accident up to the time of going to press. The mass of debris in the river and the swift current have thus far prevented any examination by divers of the base of the fallen pier.

We believe engineers will generally agree that the facts thus far presented all point to the pier and not the span as the point of original failure. It is difficult to conceive how it would be possible for the failure of a member in either of the spans, and its consequent fall, to pull the pier over. There are many accidents on record of bridge spans falling or being blown down, but we cannot recall one case where a falling span took the whole pier with it. Besides this, of the two spans that fell, the falsework had been removed from under the river span; but this fell practically intact, showing that it did not break in two and drag the other down. The falsework was still under the other span, and in case any member of that span had failed, the falsework would have supported it, in all probability. Still again, the testimony of eyewitnesses is that the pier "crumbled away."

Assuming, then, the pier to be the cause of the accident, let us see where the failure was most likely to occur. In this connection, it seems to us, that a most noteworthy feature of the accident is that it came absolutely without warning. There was no premonitory cracking or settling. Now this is exactly contrary to the way in which masonry structures act. Overloaded masonry cracks and gives warning of its condition long before final failure occurs; overloaded footings give evidence by settlement that something is wrong. To account satisfactorily for the failure of the Cornwall pier, therefore, we must find some cause which would drop the pier into the river without previous settlement or cracking of the masonry; and the only cause which seems sufficiently probable to deserve acceptance is the gradual undermining of the pier by the current.

The bed of the river is a clay hardpan, according to our best information, overlaid with the usual layer of pebbles and boulders common to swift running streams in this region of glacial action. If the current is increased in swiftness enough to remove this protecting layer of boulders the clay beneath might be gradually washed away.

It is possible that the driving of the falseworks for erecting the spans so increased the current next the piers as to wash away the boulders and clay, until finally the structure became so unstable as to topple over.

The narrow base of the pier (18 ft.), in proportion to its height (70 ft.), has been criticised. It will be readily seen that two or three feet erosion under the side of so narrow a pier leaves an uncomfortably small margin of stability. This is especially the case if the pier masonry was placed on the same side of the concrete mass as that under which erosion occurred. The reason for using such narrow cribs was, doubtless, the swiftness of the current; the difficulties of sinking cribs in such a channel, of course, increase greatly with every foot of width.

Besides erosion under the pier, the only other hypothesis which could account for the sudden failure of the pier is the bursting of the crib. If the concrete deposited under water did not set, but remained a semi-fluid mass, then it might eventually exert a pressure upon the sides of the crib which would pull out the cross braces and the whole pier would settle down. It seems quite impossible, however, that the concrete can have so absolutely failed to set as would be necessary to make this hypothesis true. It seems much more reasonable to ascribe the accident to erosion, at least until such a time as the condition of the fallen pier and crib is more fully known.


FIG. 3. VIEW OF WRECK OF THE NEW YORK & OTTAWA R. R. BRIDGE LOOKING NORTH FROM ABUTMENT ON AMERICAN SHORE.

(Sketches from a photograph taken on the afternoon of Sept. 6.)


FIG. 4. VIEW OF PIER 2 FOR NEW YORK & OTTAWA R. R. BRIDGE UNDER CONSTRUCTION.

## ANNUAL MEETING OF THE AMERICAN STREET RAILWAY ASSOCIATION.

The seventeenth annual convention of this Association was held last week at Boston. At the opening session on Sept. 6, President A. E. Lang introduced the Hon. Josiah Quincy, Mayor of Boston, who made a brief speech of welcome. President Lang then gave an address in which he referred to Boston as the birthplace of the Association, and the home of the electric railway, it being the first large city in the country to adopt the trolley system on a large scale. That the founders of the Society "builded better than they knew" was shown by the fact that no changes in the constitution had been necessary, notwithstanding the remarkable advances in street railway construction and operation. Attention was called to the need of discussion of live subjects in the convention, and the following were suggested as topics possessing considerable interest: "The Suburban Railroad;" "On What Terms and Conditions Should They Enter Over Our Tracks?" and "How Can Their Building Be Encouraged?" "The Issuing of Transfer Checks or Tickets, and How Abuses Connected Therewith Can Be Limited;" "The Equipment of Buildings with Automatic Sprinklers, and the Economy Resulting Therefrom;" "The Discussion or Agitation of Municipal Ownership of Franchises, and the Most Intelligent Way to Meet the Subject;" "To What Extent Should Companies Engage in the Amusement Business, and the Best Methods of Conducting the Same;" "How Best to Promote the Interests of Employees and in Return Secure from Them the Highest Degree of Service and Loyalty."

The report of the Secretary-Treasurer, Mr. T. C. Penington, showed a present membership of 161 companies. The total a year ago was 178, of which number 17 had withdrawn, or consolidated with other companies. The financial statement showed a balance of over $3,000 in the treasury.

The first paper, entitled "The Comparative Earnings and Economy of Operation of Single and Double Truck Cars for City Use," by Richard McCulloch, Electrical Engineer, Cass Avenue and Citizen's Railway Companies, St. Louis, Mo., is abstracted elsewhere in this issue.

In introducing the discussion which followed, Mr. Ira A. McCormack, of Brooklyn, stated the experience of his road, which operated between 300 and 400 cars, had been quite different from that given by the author of the paper, and in no instance had they been able to lengthen the headway by operating cars of larger capacity. In fact the contrary was true, and cars are now being operated under a reduced headway. As now operated, on holidays the cars which ordinarily seat 60, carry a standing total load of from 150 to 180 persons, and run on the line from Court St. to Coney Island on a 1-minute headway.

Mr. John I. Beggs, Milwaukee, Wis., gave his experience in Milwaukee, where, for the past three years, experiments have been under way to determine the advantages and disadvantages of the double truck. As a result, in 1896, 20 cars were equipped with double maximum traction trucks, and put in operation. These trucks had 30-in. wheels and the cars had 18 double seats, giving a capacity of 36 passengers. A year ago these cars were enlarged to 20 seats, holding 40 passengers, and the "maximum traction trucks" were abandoned on account of their jumping the track. The past year the car length was again increased, this time to 22 seats, holding 44, but the length between buffers was maintained the same.

In a climate such as Milwaukee, it is necessary to employ one style of car throughout the year, as the short summer season, chilly winds and cold rains, make it desirable to use only closed cars, which can be operated 12 months in the year. Notwithstanding the use of a 33-in. wheel on the cars as constructed, a distance of only 32 ins. between track and sill was obtained, which made the cars easy to enter and practically removed one of the chief objections to double truck cars. Passengers are found to prefer the comfort and higher speeds of the larger cars. On the Milwaukee roads the average speed has, within two years, been increased one mile per hour, and is now 9 miles per hour. Another factor in favor of the double truck car is the reduced wear and tear due to easier riding, and better distribution of weight, which causes lighter blows at joints, frogs, etc. Notwithstanding the increased number of trucks, wheels and springs, car repairs cost less.

His company is now operating under an increased headway as a direct result of the use of double truck cars. In reply to a question by Mr. H. N. Sloan, he stated that his company is now operating 10 interurban cars over a line 26 miles long. These cars have double trucks, and are equipped with four G. E. 1,000 motors, geared to run at a speed of 50 to 55 miles per hour. These cars weigh, when complete, about 40,000 lbs., and gave no trouble from lack of traction, or track jumping. In the near future it is the intention of the company to place four motors on all cars as two-motor cars have difficulty in mounting some of the grades, which are in a few instances from 6 to 7%.

This concluded the morning session, and the afternoon was spent in an excursion to Concord and Lexington. A special train was provided by the Massachusetts Street Railway Association, which had charge of all local arrangements, and fully 300 delegates, supply men and ladies, took advantage of the opportunity to visit these historic places.

At Concord the party walked to the park. Here two monuments mark the spot where on April 18, 1775, the British troops were opposed by the "Minute Men." Rev. C. A. Staples, of Concord, in a quaint and most interesting way, told the members of the excursion party the story of the Concord battle, and pointed out the spots of historic interest.

Again boarding the train the party was carried to Lexington, where carriages were waiting to carry them about the town. The many monuments, the battlefield, Sleepy Hollow Cemetery, where Emerson, Hawthorne, Thoreau and the Alcotts are buried, and the other historic points were viewed with interest by the visitors.

In the evening a reception was held in the Paul Revere Hall, and passed most pleasantly under the efficient direction of the Ladies' Committee of the Massachusetts Street Railway Association.

Wednesday, Sept. 7.

The first paper was read by Mr. W. S. Dimmock, General Superintendent Omaha & Council Bluffs Ry. & Bridge Co., Council Bluffs, Ia., and discussed the postal service on street railways.

Mr. Dimmock said that the advantages to the business community of a street railway postal service were conceded on all hands, and the only ground for discussion, was the compensation given the companies for this valuable service. In the beginning street railway companies were anxious to carry the mails, believing as they did, that it would insure to them a complete protection by the government during strikes. In consequence they accepted rates, which when they found the protection was not as complete as expected, were considered too low. At present a fixed rate of 3 cts. per car-mile has been established by the government for street railway postal service, while the "Star Route" service costs 4.94 cts. per mile. Congress fixed this rate and made the appropriation; and it is quite within the province of the American Street Railway Association to sufficiently influence Members of Congress to have the present injustice to street railway companies remedied.

Mr. John I. Beggs, Milwaukee, Wis., said that the company which he represented was considering the carrying of U. S. mail upon its lines. So far he had opposed even carrying pouches, since it did not seem to promise any adequate return and the resulting protection did not seem to amount to much. The low rates were originally accepted by some railway companies solely to obtain the protection of the government, and the government was now attempting to force these low rates on all companies, regardless of location or surrounding conditions. The rate offered was really below the cost of operation in several cases, and yet the mail car must always have the right of way. The advantages of carrying mail pouches on platforms was questionable, as the space could be put to far more profitable use in carrying passengers, many of whom would rather ride on the platform than any other place.

Mr. Robert McCulloch, St. Louis, Mo., stated that his company had equipped two cars for postal service, intending to operate them at an inadequate rate, but expecting to derive the benefits of a United States mail route. Upon their first appearance, orders were given to have the U. S. mail signs removed from the cars.

Mr. H. C. Payne, Milwaukee, Wis., thought that the postal authorities were willing to treat the railways fairly. The trouble lies with the Congressional appropriations and not with the Department. If the matter were properly presented to the committee having in charge the Post Office appropriations there was good reason to believe that a change would result, for he found the Department officials uniformly willing to do what was fair. It would be necessary to have a committee with proper data visit Washington, and present the matter to the Congressional committee. A motion was carried to this effect; the committee to consist of five members to be appointed later.

The Secretary then read a paper by Mr. M. S. Hopkins, Electrician, Columbus Street Ry. Co., Columbus, O., entitled "Maintenance and Equipment of Electric Cars for Street Railways." The paper is abstracted elsewhere in this issue.

Mr. H. N. Sloan, Chicago, Ill., disagreed with the author regarding the inadvisability of night inspection. With his company this inspection had proved very satisfactory, all motor brushes being changed each night. As a result, commutators required turning down less frequently.

Before the adjournment of the morning session, President Lang announced the Nominating Committee as follows: W. W. Bean, D. G. Hamilton, E. C. Foster, W. F. Kelly, J. R. Chapman, Henry C. Payne and E. H. Davis.

The excursion of the afternoon included a steamer trip down the bay to Nantasket Beach, affording on the way down an excellent view of the battleship "Massachusetts," the "Solace," several smaller gunboats, and the shipping of Boston Harbor. At the Beach the visitors divided, some going in bathing, and others taking a trip over the Nantasket Beach Electric road. Later a "clam bake" was participated in by all, over 700 sitting down in the large dining-room of the Ocean View Hotel.

Thursday, Sept. 7.

This session began with the reading of a paper by Mr. Walton H. Holmes, General Manager, Metropolitan Street Ry. Co., Kansas City, Mo., entitled "To What Extent Should Street Railway Companies Engage in the Amusement Business." In this paper it was stated that conditions varied in each city, but there were certain general rules which could be laid down. The conditions of life in most cities has changed during the last few years, and in addition to police and fire protection, means of amusement, such as parks, and boulevards, were now provided. Municipal authorities were only too glad to have street railways help by constructing lines to city parks, or by constructing and operating parks of their own. Many roads did not consider new resorts paying investments, and found it advisable to improve transportation facilities to parks already existing. In many large cities the question was, however, how to properly take care of existing traffic, and not so much how to increase it. Smaller cities do without doubt afford an opportunity for recreation parks such as defined in the title of the paper. There is little difference in the kind of recreation required at these parks, usually music, baseball, football, roller coasters, boats, chutes, light comedy, balloon ascensions, etc., suffice to increase the light traffic of summer and bring the balance on the right side of the ledger.

Mr. C. D. Wyman, New Orleans, La., said that at one time he was firmly convinced that a railway man should stick to his own line of business. Recently, however, he had discovered that local conditions affect the question. In his experience the people who conduct recreation grounds, outdoor sports, etc., were not always reliable, and some supervision by the railway company was advisable. In some cities, especially in the South, it was at present not customary for people to leave their homes in the afternoon or evening of the summer months, and it was for the progressive street railway companies to break up this custom. The road he represented had established parks, with attractive entertainment, with very gratifying results. Considering the question as a whole, he was convinced that the amusement business in connection with street railways paid.

Mr. John I. Beggs, Milwaukee, Wis., said that his company had for some time given, at its own expense, band concerts in one of the city parks, and had a standing offer to duplicate any money raised by the city or any public spirited citizens for similar entertainments. The result had finally convinced him that the gain in traffic income did not warrant the increased expense, and that it did not pay street railways to go into the amusement business, at least in this way. While the company's income was increased, the operating expenses were also increased at a greater rate, and in his case the returns were found to be only about 75% of the expenditures. In many cities considerable traffic was concentrated on one line and forced in one direction which would ordinarily have distributed itself in several directions.

Mr. W. E. Harrington, Camden, N. J., said that his company had a free park, and the number of outsiders caused so much trouble that it was necessary to charge a small entrance fee. The number entering was registered by turnstile, and it had been found that they were receiving only about 70% of the money expended.

Mr. A. E. Lang, Toledo, O., remarked that his city had a population of about 140,000 inhabitants, and the railway owned a park on the lake front about 5½ miles distant. The original owners had started on rather a large scale, charging no admission and furnishing seats in any part of the Casino building free. The original cost of park and equipment was $65,000. As soon as his road came into control an admission fee of 5 cents was charged, all coming by car, or 15 cts. for the round trip. Instead of free seats, a number were reserved and charged for at 10 cts. Last year, instead of a loss, the Casino cleared a few hundred dollars, and the increased earnings of the railway company amounted to $40,000. This year the Casino Company will net $6,000 and the railway company about $50,000.

Col. N. H. Heft, Meriden, Conn., was glad that railway men were maintaining their reputation for honesty and truthfulness by telling just what they were doing. His company had inherited a park costing $45,000, with free launches, switchback, pavilion, etc., and their experience with it had been somewhat unfortunate. Street railway men were running wild over the amusement question. The whole matter must be run on a sound business basis.

Mr. W. W. Bean, chairman of the nominating committee, presented the following list for officers for the ensuing year:

President, Chas. S. Sergeant, Boston, Mass.; First Vice-President, H. C. Moore, Trenton, N. J.; Second Vice-President, Earnest Woodruff, Atlanta, Ga.; Third Vice-President, W. H. Holmes, Kansas City, Mo.; Secretary-Treasurer, T. C. Pennington, Chicago, Ill.; Executive Committee, A. E. Lang, G. E. Yuille, Frank Jones, John I. Beggs and Ira A. McCormack.

For the next annual convention Chicago, Ill., was chosen. The report was accepted and the secretary ordered to cast the ballot for the nominees.

President Lang named the following gentlemen as members of the committee having in charge the question of carrying United States mails on street railways: J. T. Burnett, Boston; H. C. Payne, Milwaukee; Ira A McCormack, Brooklyn; D. G. Hamilton, Chicago, and W. S. Dimmock, Omaha.

The President also announced the presence of two railway engineers from Japan who had been attending the Association meetings, Messrs. T. Y. Dzushi, Chief of Finances and Manager of Stores of the Imperial Government Railways, and K. Sugahara, Chief Engineer of the Kobe Railway and of some street railways built in Japan. Upon motion, the privileges of the floor were extended to both gentlemen.

The second paper of the morning session, by Mr. Frederick B. Perkins, electrical engineer, Toledo Traction Co., Toledo, Ohio., entitled "Inspection and Testing of Motors and Car Equipments by Street Railway Companies," is abstracted elsewhere in this issue. There was no discussion.

The afternoon was occupied pleasantly by a trip to Plymouth, the special train leaving Old Colony Station at 2 p. m., and returning about 6 p. m., in ample time for the annual banquet, held at the Hotel Brunswick, the convention headquarters, at 8 p. m. Covers were laid for 350 persons, and the after-dinner speakers included Mayor Quincy, Hon. Geo. G. Crocker and other prominent men.

Friday, Sept. 9.

The session was opened with the reading of a paper by Mr. R. W. Conant, Electrical Engineer, Boston Elevated R. R. Co., entitled "Cost of Electric Power for Street Railways at Switchboard; Both Steam and Water." This was, without doubt, the most complete and valuable paper of the convention. We postpone its publication to our next issue. There was no discussion upon it.

The Committee on Rules for Government of Motormen and Conductors asked for an extension of time and the appropriation of $200 to permit the printing and mailing of the code prepared by them, the intention being to submit it to the members for revision and criticism. Both requests were granted. The new President, Mr. Chas. S. Sergeant, briefly addressed the members, and the final adjournment was then taken.

The convention, as a whole, is generally conceded to have been the most successful in the history of the Association, unquestionably so from the exhibition and entertainment standpoint.

While the street railway managers and engineers were in session in the main hall the Street Railway Accountants' Association was busily engaged in another part of the building.

The papers read were as follows:

"Statistics—Their Use and Abuse," Mr. E. D. Hibbs, Auditor, North Jersey Street Railway Co., Jersey City, N. J.; "Car Mileage—How Arrived at and Its Use," Mr. A. H. Ford, Secretary and Treasurer, New Orleans Traction Co., New Orleans, La.; Report of the Permanent Committee on "A Standard System of Street Railway Accounting, Covering the Classification of Operating Expenses, Classification of Construction and Equipment Accounts and Form of Annual Report." Chairman C. N. Duffy, Secy., Citizens' Ry. Co., St. Louis, Mo.

The election of officers for the ensuing year resulted as follows: Pres., J. T. Calderwood, Minneapolis; First Vice-Pres., E. R. Tighe, New York; Second Vice-Pres., R. L. Williams, Richmond, Va.; Third Vice-Pres., F. E. Smith, Lynn; Secy. and Treas., W. B. Brockway, Toledo, O.; Executive Committee, Chn., H. L. Wilson, Boston; H. E. Babcock, Elmira, N. Y.; H. O. Mackay, Milwaukee, Wis., and J. D. Fraser, Ottawa, Canada.

The selection of the Mechanics' Building, Boston, Mass., as a place of meeting insured an ideal location for both the exhibition of street railway appliances and the regular business session.

The attendance was most gratifying, including, as it did, about 900 supply men, 300 delegates and about 300 ladies, a total of about 1,500 persons. All were accorded the freedom of the Boston street railways, the convention button serving as a pass on all the city and suburban lines. The exhibition was, as already stated, the largest in the history of the Association. The exhibits, which occupied two full floors of the Mechanics' Building, are briefly described in the Supplement of this issue.